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Psychological constraints on tax evasion an experimental approach.

Psychological constraints on tax evasion: an experimental approach

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Abstract

This dissertation studies tax evasion as a phenomenon tied to psychological and moral costs. It starts from a theoretical formulation of the tax payer's decisional problem which incorporates two psychological elements into the usual expected utility maximisation approach. The first of these components is based on the assumption that people "dislike" being discovered guilty of evasion, while the second one is founded on the hypothesis that tax payers feel their awareness that they are stealing their contribution to the tax yield from the other citizens as a moral cost.

The theoretical model was tested by carrying out seven experiments involving 274 experimental subjects. The results of the experiments seemingly confirm the importance of the role played by the second of the psychological elements considered by the theoretical model, while the first one is of only marginal importance.

Another important finding to emerge from the experiments is that the traditional theoretical treatment of uncertainty and risk could not be used to provide a satisfactory explanation of the experimental subjects' behaviour when faced by the uncertain choice of evasion. When the experimental subjects had to cope with a repeated choice problem, they developed a sort of learning strategy, using a trial and error process to explore the space of alternatives. They thus produced a personal "style" in solving the uncertainty problem. The dissertation shows that is possible to produce a concise taxonomy of these game styles which could be used as the basis for further theoretical analysis.

To Antonella, Chiara and Elena

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The writing of this dissertation has benefited of the help of many persons, ranging from my Supervisor Ian Jewitt, to Massimo Egidi, who is the Director of the Computable and Experimental Economics Laboratory of the University of Trento, to the participants at two seminars held at the Department of Economics of the University of Trento. A research of the kind here described is not possible without the collaboration of a multi-disciplinary staff. In fact one of the most fascinating experience that I had by carrying out this dissertation was to co-ordinate a group of young and enthusiastic people from the Computable and Experimental Economics Laboratory of the University of Trento. Among them I wish to thank in particular the computer scientist Paolo Patelli, following a project that we jointly discussed he developed the software used to carry out the repeated choices experiments. I also wish to thank my students for making the practical realisation of many experiments possible. Among these I am especially grateful to Alessandra Gaburri, who, under my supervision, collected the literature on the theory and experimental investigation of tax evasion that formed the basis for chapter 2. Last but not least I wish thank my friend and colleague Luigi Bosco, my co-author of an article published by *Kyklos* and partially incorporated in chapters 3 and 4 of this work.

A final thank goes to the Department of Economics of the University of Trento that has provided the financial support for carrying out the experiments.

AUTHOR'S DECLARATION

I declare that the work in this dissertation was carried out in accordance with the Regulations of the University of Bristol. The work is original and no part of the dissertation has been submitted for any other degree, except where indicated by special reference in the text or in the acknowledgements.

Any views expressed in the dissertation are those of the author and in no way represent those of the University of Bristol.

The dissertation has not been presented to any other University for examination either in the United Kingdom or overseas.

SIGNED: 18 September 1998

Contents

List of tables and figures

Tables

Figures

Preface

In the first edition of *Administrative Behaviour* Herbert Simon, citing the story of a statistician who had found a very close correlation between the number of old maids and the size of the clover crop in different English counties, wrote:

> "...After puzzling over this relation for some time, he (*the statistician*) was able to trace what appeared to him to be the causal chain. Old maids, it appeared, kept cats; and cats ate mice. Field mice, however, were natural enemies of bumble-bees, and the latter were, in turn, the chief agents in fertilising the flowers of the clover plants. This implication, of course, is that the British Parliament should never legislate on the subject of marriage bonuses without first evaluating the effect upon the clover crop of reducing the spinster population." (Simon, 1976, p. 82).

Simon used this anecdote to stress that it is virtually impossible to take serious account of all the possible factors explaining a given phenomenon, but it can also usefully introduce the potential complexity of the theme treated in this work: that is, analysis of the micro-economic reasons that may determine the decision to evade taxes. Inspection of the applied literature shows that the number of the elements able to influence the decision process of a tax payer is very large, and that it can easily be enlarged even further. The purpose of exploring these factors is similar to that exemplified by Simon's anecdote: that is to say, it is normative in nature. To produce a good fiscal system, it is necessary to induce people to pay taxes. Every fiscal law should therefore comprise the best possible constraints on tax evasion. The aim of this work is to explore the role played by some psychological, *moral* constraints on tax evasion, and to verify their effect when they are combined with other more traditional deterrents, like those embodied in the punishment system.

Although the topic treated here is studied both theoretically and empirically, it is the latter perspective that receives the closest attention. More precisely, I have used the experimental approach to check a set of hypotheses formulated in the opening theoretical chapter on the role played by certain psychological elements: a *Kantian* moral constraint, a *social* moral constraint, and a tax fairness effect.[1] My decision to give priority to empirical inquiry over theory is due to the substantial formal soundness

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of tax evasion theory, which largely prevents any radically new development of the topic.[2] By contrast, new insights can be obtained by testing the theory in the field, and for this purpose one of the most powerful tools available is economic experimentation. The reason of this predominance is well known, namely the fact that evading taxes is a crime, and for this reason people have powerful incentives to conceal information about their true behaviour.

The work is divided into three main parts. Part One is devoted to analysis of two correlated literatures: the first concerning theoretical approaches to tax evasion, the second concerning experiments on tax evasion. The second part of the dissertation describes the theoretical framework adopted to design the experiments. Finally, the last part outlines the experiments and the results obtained therefrom.

The experiments here discussed have been carried out at the Computational and Experimental Economics Laboratory of the University of Trento Italy. For this reason in the following section I have given some predominance to the data concerning tax evasion in Italy.

1 Introduction

Tax evasion is one of the most widespread forms of criminal behaviour in the world, and it is probably the one that is the most culturally 'accepted'. Indeed, under certain conditions, citizens may perceive tax evasion as constituting a legitimate defence against an unjust and oppressive state. The close connection between the decision to evade taxes and the moral justifications cited by evaders to absolve their consciences closely influence taxpayers' decision-making, and renders it of particular interest to the economic researcher. This short introduction sets out some data from studies of tax evasion in Italy and other Western countries. The chapter is purely introductory in purpose and lays no claim to exhaustive treatment of the subject.

[2] Many interesting theoretical contributions to the original Allingham and Sadmo's model of tax evasion have been developed in the last three decades, for a survey see Cowell (1990).

1.1. Tax evasion in Italy and in some Western countries

Studies aimed at quantifying tax evasion have been conducted in almost all the Western countries. The estimates available for Italy and for the European countries mainly concern indirect indices, i.e. the tax base that escapes the revenue system, while measures of the amount of revenue evaded are almost entirely lacking (Bernasconi, 1995). As well known the chief reason of this fact is that the information available on tax evasion is limited and unreliable because tax evasion is a crime and therefore it falls into the category of phenomena that feed the so called hidden economy. It should be stressed that here I am interested only in tax evasion. Consequently, I shall ignore other kinds of 'legal' behaviour, like tax avoidance, which may reduce the individual tax burden without exposing the tax payer to the risk of punishment.

There are two ways to evade taxes: the first is to conceal the activities related to the fiscal burden; the second is simply to underreport the amount of the tax burden. According to many authors (e.g. Alesina and Marè, 1996), there are two approaches available in investigation of these forms of tax evasion : the *direct* approach and the *indirect* one. Direct methods are used mainly to estimate the tax burden underreported, while indirect methods are used when the object of the investigation is tax evasion consequent on the hidden economy.

Direct methods are all based on the auditing of samples of taxpayers. Two techniques are used: the compulsory and the voluntary. A compulsory audit can only be carried out by the revenue authorities, and it consists of a fiscal inspection of a sample of taxpayers who are investigated from many perspectives (with data collected not only on fiscal aspects but also on their economic and social profiles). On the assumption that the sample selected is statistically representative of the entire population of taxpayers, this method should yield a very good assessment of tax evasion. The problem, however, is that this kind of investigation is mainly carried out on specific categories of taxpayers, because the revenue authorities are primarily interested in detecting tax evasion as a crime and must therefore concentrate their resources only on those taxpayers whose income declarations already contain some circumstantial evidence of likely tax evasion. Another drawback to this method of enquiry is that the revenue authorities can only detect taxpayers who are in some way known to their offices, while they have great difficulty in detecting total evaders (O'Higgins, 1980, 1981).

Voluntary audits are interviews conducted with a sample of taxpayers who agree to reply to a set of questions designed to reveal forms of black economy. The drawback to this second method of direct enquiry is obvious: people who are concealing their activities have very little reason to report honestly to the interviewers.

Indirect methods can be divided into three main groups (Alesina and Marè, 1996):

a) the macroeconomic approach, which is mainly based on calculation of the difference between the taxable income declared and that deducible from the national accounting data;
b) the monetary approach, which is based on the assumption that subjects wishing to hide their activities tend to conduct their transactions in cash; therefore, the growth of currency should reflect the size of the black economy (many different methods make partial use of this approach);
c) estimate of the ratio of participation in the job market.

The monetary approach is the one most widely used, despite the fact that it suffers from a methodological limitation, namely the difficulty of drawing a precise distinction between the currency excess due to the hidden economy and the amount of currency 'physiologically' required by the economic system. Similarly, the macroeconomic approach also suffers from a major weakness, namely the high likelihood of measurement errors due to the data-collecting methods used (Cowell, 1990). On the other hand, it should be pointed out that this problem is common to all indirect methods. Consequently, the lack of a totally problem-free method often suggests that several sources and approaches should be used.

When looking for data on the size of the hidden economy in Europe, one finds that a quite large body of research has produced quantitative estimates of the phenomenon. Unfortunately, the data are highly heterogeneous, and moreover they do not always refer to the same years. A comparison among authors who have used the monetary approach is provided by Table 1.1.

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Table 1.1 The hidden economy in some Western countries (% of GNP)

Country	method used	1975	1976	1977	1978	1979	1980	1981	1982	1983	1991
USA	Feige (1989)		17		29-33	27					
	Gutmann (1985)	10	11	11.7	12.4	13.1	14.3				
	Tanzi (1982)	5	5.5	5.2	5.3	5.4	6.1				
	Frey (1983)				8.3						
Canada	Frey				8.7						
UK	Feige	14	14	15	14	14.5					
	Frey				8						
Germany	Feige	16	18	23	24	24	27				
	Tanzi	4.3-6.5					8.1-13				
	Frey				8.6						
Ireland	Gutmann	8.7	9.4	5.8	4.3	9.2	10	11.8	14.2	15.1	
	Frey				7.2						
	Tanzi	2.8	4.4	3.8	3.8	3.8	5.3	6.2	7.3	8.1	8.2
Italy	Frey				11.4						
	Martino						25-33				
	Contini			14-20							
	DeGrazia				10-25						
France	Frey				9.4						
	Barthelemy (1988)					6.3					
Norway	Frey				9.2						
	Tanzi-Klovland	2.6	4.3	4.7	6.3						
Spain	Frey				7.6						
Japan	Frey				4.1						

Source: Alesina and Marè, 1996, p. 93

Table 1.1 highlights the wide variability of the estimates produced by different authors for the same country. For example, the estimated size of the American hidden economy in 1978 varies from a minimum of 5.3% of GNP (Tanzi) to a maximum of 33% (Feige). A similar wide discrepancy can be seen for several years in the case of Ireland, whose hidden economy Tanzi estimates as a phenomenon which grows constantly from an initial value of 2.8% in 1975 to a maximum of 8.2% of GNP in

1991, while Gutmann considers it to be some sort of cyclical process fluctuating between a minimum of 4.3% (1978) and a maximum of 15.1% of GNP (1983).

In spite of these marked discrepancies among estimates, interesting information is yielded by Table 1.1 if we look at the estimates suggested by Frey for all the countries considered in the table, even if only for one year. According to Frey, the country with the largest hidden economy in 1978 was Italy (11.4% of GNP), while the country with the smallest hidden economy was Japan (4.1%). Assuming that Frey's estimates are correct, at least as regards the relative distance between these two countries, we may hypothesise that in 1978 the amount of tax evasion due to the hidden economy in Japan was about 120% lower than in Italy.

Confirmation of the magnitude of tax evasion due to the hidden economy in Italy has been provided by Alesina and Marè (1996), whose estimates are reported in Table 1.2.

Table 1.2 Tax evasion and the hidden economy in some Western countries (% of GNP)

Country	method used	1970	1975	1980	1985	1990
Belgium	Monetary		11-15	3.8-20	17-18	
	Macroeconomic		11	11		
Italy	Monetary		13.9-18	20-30	20	15
	Macroeconomic		8.5	14.2		
Ireland	Monetary		1.3-8.7	3.3-10	8.1-13.6	7.9-9.5
	Macroeconomic			0.5-5		
France	Monetary			6.3-6.7		
	Macroeconomic					
Germany	Monetary	3.1-16	3.4-12.1	3.7-14		
	Macroeconomic	5-8.9	4.8			
USA	Monetary		3-14	4.5-14	10-15	
	Macroeconomic		1.5-4	4.5		
UK	Monetary	11	2.9-13	2.9-14	14.5-15.9	
	Macroeconomic	1.5	1-4	2.5-5.5	3.5	

Source: Alesina and Marè, 1996, p. 95

Inspection of Table 2.1 once again evidences the importance of the hidden economy in Italy compared with other countries. Again following Alesina e Marè, if tax evaders in Italy had evaded taxes in 1970 to an amount equal to that evaded by American tax evaders, then in 1992 the national debt would have been about 30% lower.

Therefore, if we restrict the analysis only to Italy, which seems to be the country in which tax evasion has assumed the greatest economic importance, and if we look at the two main forms of levy (i.e. indirect and direct taxes), we can gain better understanding of the phenomenon.

With respect to Italy (Bernasconi, 1995), indirect indices of evasion are available for IVA (value added tax), for social security contributions, and for IRPEF (taxation on personal incomes). The first estimates of IVA evasion refer to the years 1977-84. During this period, according to Bernardi and Buratti (1986), about 20% of the tax base in industry and 30% in the commercial sector was evaded. More recently, for fiscal data relative to 1986, Cerea (1992) has confirmed the 30% figure for evasion in the commercial sector but stresses that this figure errs on the side of caution (Table 1.3).

Table 1.3 Estimates of tax evasion relative to IVA

	INDUSTRY	COMMERCE
Bernardi (1986) (1)	20%	30%
Cerea (1992) (2)		30%

(1) figures for 1977-84

(2) figures for 1986

Source: Gaburri, 1996

While Bernardi's estimates are based on a quite traditional macroeconomic approach (the difference between the taxable income declared and that deducible from the national accounting data), Cerea's method is essentially a presumptive approach and estimates evasion on a regional basis (Cerea 1992, p. 165). A significant finding of Cerea's study is the heterogeneity of IVA evasion in various parts of the country: in fact, the aggregate figure of 30% is an average of values of around 23% in the central-northern regions of the country and 32% in the south.

A larger number of studies have examined the evasion of IRPEF (Bernasconi, 1995). Various estimates are set out in Table 1.4, where the evasion indices refer to the ratio between evaded income and the effective tax base.

Table 1.4 Estimates of the evasion of direct taxes by category of income				
Authors	Year	Dependent employment	Other incomes	Total tax base
Vitaletti	(1979)[1]	11%	58%	26%
Visco	(1983)	10%	44%	26%
Bernardi	(1984)	6%	55%	24%
Vitaletti	(1984)	9%	56%	28%
Militello	(1986)	10%	32%	19%
Visco	(1987)	11%	56%	46%
Fossati	(1989)	21%	52%	33%

(1) old accounting system

Source: Gaburri, 1996

Table 1.4 highlights two significant features. The first I have already pointed out when commenting on previous tables: the differences among the estimates made by different authors for the same year, or for years very close to one another. The second concerns the values relative to the two forms of income (from dependent employment and from self-employment) considered. Bernardi (1989) and Vitaletti (1986) give almost identical figures for the 1984 item 'other incomes', whereas only two years later Militello (1986) and Visco (1987) provide extremely diverse estimates, thereby creating a marked difference in the overall estimate of tax evasion. As regards evasion in the two forms of income, all the authors agree that evasion is more evident in 'other incomes', where the average is around 45%-50%.

The most recent estimates of tax evasion in Italy refer to 1991. They were made by the Ministry of Finance and published in the *Relazione tecnica* attached to government bill no. 45 presented to Parliament in 1994. According to this report (Table 1.5), the revenues uncollected due to the evasion of direct and indirect taxation amounted to *c.* 100 thousand billion lire, to which sum should be added the *c.* 26 thousand billion evaded in the area of social security contributions. The method used belongs to the macroeconomic approach, the main particularity being that evasion has been calculated with reference to the private sector of the economy alone, on the assumption that public-sector operators do not evade taxes.

The figures set out in Table 1.5 allow one to state, albeit with some approximation, that of the 126 thousand billion lire of tax revenue lost in Italy, 93 thousand billion was due to the evasion of income taxes (including social security contributions), equal to *c.* 24% of the expected yield, and 33 thousand billion to IVA evasion, equal to *c.* 34% of the yield. In addition to this evasion, a further 40 thousand billion lire of revenue was lost as a result of exemptions, exceptions and loopholes.

Table 1.5 Estimates of tax evasion in Italy for 1991

Revenues lost on incomes in 1991	(billion of It. liras)
Value added in the private sector taxable as personal or business income	980,000
Revenue predicted on the basis of an average tax rate of 45% (income taxes + social security contributions)	440,000
Effective revenue (income taxes + social security contributions)	292,000
Lost revenue on incomes	148,000
Revenues lost on IVA in 1991	
Consumption by households net of IVA	830,000
Revenue predicted on the basis of an average rate of 11,4%	95,000
Effective IVA	62,000
Lost revenue from IVA	33,000
revenue lost on incomes adjusted by revenue lost on IVA	15,000
total revenue lost	166,000
estimate of revenue lost because of allowances, reliefs and loopholes	40,000
estimated evasion of taxation on incomes and IVA	100,000
estimated evasion of social security contributions	26,000
evasion projected for 1989-1990-1991-1992-1993 on the basis of evasion in 1992	500,000

Source: *Corriere Tributario* (1994)

1.2 Some lessons from the data

This brief analysis of the data on tax evasion highlights two features in particular. The first is that tax evasion is a critical phenomenon in many countries, and that in some of them, like Italy, it greatly influences the national budget. The second is that macroeconomic data yield only weak information on the microeconomic factors that influence tax evasion. Finally, a third lesson to be drawn is that income tax evasion creates the greatest loss for the national budget.

The microeconomic determinants of tax evasion revealed by the data just discussed are mainly circumscribed to the fact that tax evasion is more frequent when the tax burden is made up of incomes from activities different from dependent employment (Table 1.4) and that tax evasion is more likely in some geographical areas (like the South of Italy) than in others (Table 1.5). Nothing can be said about more complex determinants like, for example, the existence of a relationship between the type of the punishment system used in a given country and the amount of tax evasion. This kind of analysis is almost impossible using macroeconomic data because it is very difficult to isolate a specific influencing factor from the others.

Macroeconomic data are even more difficult to use in investigation of the relationship between tax evasion and individual factors like psychological or moral constraints. These elements can be more easily analysed if the following approaches are used:

- *the theoretical approach*, whose increasingly complex hypotheses and models now enable sufficiently thorough account to be given of the factors that determine tax evasion;
- *the experimental approach* based on simulation-games and which mainly seeks to verify the results of theoretical inquiry.

As already anticipated in the preface, I shall ignore the macroeconomic applied approach, concentrating only on the theoretical and experimental ones. My decision to neglect the traditional macroeconomic approach and to focus instead on experimental aspects is not due to any rejection on my part of the usefulness of this approach. It is instead prompted by the nature itself of the phenomenon of tax evasion. I believe that tax evasion as unlawful behaviour lends itself well to the abstraction from the real context which the experimental approach makes possible. Those who decide to evade taxes know that they are liable to punishment and therefore have reason to conceal their behaviour. The experimental approach has instead the advantage of distancing subjects from the real context. It therefore does not elicit self-defence by the subject examined and as a consequence is useful from this point of view and for this type of analysis. The advantages of the approach can be summarised as follows:

- it allows closer control to be exerted when new explanatory variables are introduced, thus yielding clearer understanding of the causal relations among the various factors considered;
- it circumvents the problem of ensuring that people give truthful information about illegal behaviour;
- it generates a considerable quantity of data at a relatively low cost.

Of course there are drawbacks to the approach. These should be borne in mind because they may influence assessment of both the results of the experiments presented below and those set out in the experimental literature. The most serious of these drawbacks are the following:

- the risk that the experiment will be excessively abstract and therefore unrepresentative of the phenomenon;
- the risk of excessive complication, and therefore of distortion in interpretation of the results due to the subjects' scant attention to the task, and to the application of behavioural models and decision-making rules partially or wholly different from those normally employed in reality.

Before directly analysing the experiments carried out on tax evasion, brief discussion is required of theoretical and experimental contributions to this topic.

2 The theoretical and experimental study of tax evasion

In this chapter I shall examine theoretical approaches to tax evasion while also surveying the main experiments carried out on the phenomenon. The analysis of theoretical studies that follows will serve solely for discussion of the results obtained from the experiments described in the next section. More precisely, I shall set out the theoretical models that have prompted the experiments that have been conducted to date. For this reason the survey of the theoretical literature will only be partial: it will omit, for example, studies like that produced by Cowell (1990). The three strands of theoretical analysis considered here are those of microeconomic theory, prospect theory, and attribution theory.

2.1 Theoretical models of microeconomic derivation

The various economic models of taxpayer behaviour are analysed using, for the sake of convenience, two types of evasion: that by the free-rider taxpayer, and that by the disgruntled taxpayer. The former category comprises individuals who seek wholly or partially to avoid paying taxes because other individuals already pay them. The latter category comprises individuals who regard evasion either as a means of self-protection against an unfair tax system, or as a means to perform a certain activity which otherwise would be subject to an excessively heavy tax burden (Cassone and Cogno 1987).

2.1.1 Free-rider models

The overall approach of this first group of theoretical studies has been inspired by the economic analysis of crime and unlawful activity developed principally by Becker (1968). The cornerstone of this approach has been well summarised by Becker himself: "Some persons become 'criminals', therefore, not because their basic motivation differs from that of other persons, but because their benefits and costs differ" (Becker, 1968 p. 9). More specifically, Becker's proposal is to devise a criterion for calculating the optimum level of punishment, given the costs of running the system of identification and application of penalties, and given the reaction of individuals to these penalties. This entails multi-disciplinary analysis which in some way ties themes from criminology and jurisprudence to economic evaluation (Cassone and Cogno 1987).

The legacy bequeathed to the economic theory of taxpayer behaviour by the economics of crime is the relation between the likelihood of punishment and the advantage deriving from evasion. In other words, microeconomic theory applied to tax payment bases itself on the principle that the decision whether or not to declare income - so that the revenue system can calculate the amount of tax payable on it - is essentially a decision taken in conditions of uncertainty. Taxpayers can truthfully declare their taxable income and pay the corresponding amount of tax to the revenue office according to the law, thus establishing with certainty their net income. Or they can choose to declare an income lower than their taxable income in an attempt to evade taxes partly or wholly, but in doing so expose themselves to the risk of a punishment which will reduce their income to a level much lower than it would have been had they paid the tax. The decision 'whether' to pay tax and 'how much' is therefore taken in conditions of risk because the taxpayer cannot know *a priori* what the outcome of evasion would be. As well known in microeconomic theory, the problem of choice in conditions of uncertainty was first addressed by Von Neumann and Morgenstern, who solved it using the maximisation of expected subjective utility.

There follows a brief survey (Gaburri, 1996) of the models of microeconomic derivation applied to taxpayer behaviour. I shall discuss Alligham and Sandmo's model (1972), Yitzhaki's model (1974), Srinivasan's model (1973), Fishburn's model (1979), and Yaniv's model (1994). All these models start from a shared description of the taxpayer problem. That is to say, they hypothesise that only two possible states of the world can ensue from the taxpayer's income declaration, viz.:

- *non-assessment* by the tax authorities of the taxpayer's effective taxable income; in this case, if the taxpayer has not declared an income equal to his/her actual income, s/he has a higher disposable income;
- *assessment* by the tax authorities of the taxpayer's effective taxable income; in this case, and on the assumption that the taxpayer has not declared his/her actual income, the evader will not only be compelled to pay the entire taxation due on his/her actual taxable income, but s/he will also have to pay the fine provided by the law. The taxpayer

will therefore be left with a disposable income lower than what it would be if s/he had made a truthful declaration. The final value of the expected utility function is calculated as the sum of the two possible levels of utility, which depend on the two possible disposable incomes, weighted with their respective probabilities of occurring.

In the next sections the following symbols will be used:

E(U) = expected utility function;

Y = a person's taxable income;

X = declared income;

k = (Y-X)Y;

Z = ex-post income if assessment is made;

H = ex-post income if assessment is not made;

t = tax rate;

P = penalty applied to evasion;

p = penalty-rate on undeclared income

m = penalty-rate on the total of unpaid taxes;

π = likelihood of assessment.

All the models analysed here consider the static case, with the sole exception of Alligham and Sandmo's model, which deals with the dynamic case as well. Given that all studies subsequent to Alligham and Sandmo's (henceforth AS) start from the static case analysed by these authors, it is advisable to begin with the static models and then examine the dynamic version of the original model.

Static models

These models analyse the situation in which the taxpayer makes only one tax declaration, which does not depend on past declarations and does not condition future ones. As already said, the base model is contained in Allingham and Sandmo's study (1972). It is based on the following assumptions:

- $H_{AS}1$: the taxpayer's behaviour conforms with von Neumann and Morgenstern's axioms for behaviour in conditions of uncertainty: i.e. it seeks to maximise expected utility;

- $H_{AS}2$: the only argument of the taxpayer's utility is income, and it is twice differentiable;
- $H_{AS}3$: the taxpayer is risk-averse; consequently his/her utility function is positive, increasing and strictly concave for a positive income; therefore the marginal utility function is positive and strictly decreasing;
- $H_{AS}4$: when compiling his/her tax return, the taxpayer chooses, in conditions of uncertainty, to declare the fraction of income that will maximise the expected utility of the disposable income remaining after payment of taxes and possible fines;
- $H_{AS}5$: the sanction is proportional to the undeclared income.

The taxpayer maximises expected utility defined as a linear combination of individual concave utility functions:

$$E(U) = (1-\pi)U(H) + \pi U(Z)$$

with $H = Y\text{-}tX$ ex-post income in the case of non-assessment;

$Z = Y\text{-}tX\text{-}p(Y\text{-}X)$ ex-post income in the case of assessment.

$$E(U) = (1-\pi)U(Y-tX) + \pi U[Y-tX-p(Y-X)]$$

Given income Y, and with the tax corresponding to each level of income and the fine payable on undeclared income [P(Y-X)] being known, as well as the relative probability of assessment, the utility function depends on the decision about the amount of income to declare, the level of which lies between 0 and Y.

The first order condition for maximising the function is:

$$\partial EU/\partial X = - t(1-\pi)U'(H) + (p-t)\pi U'(Z) = 0;$$

The second-order condition is:

$$D = t^2(1-\pi)U''(H) - (t-p)^2\pi U''(t) < 0$$

which is satisfied hypothesising the concavity of the utility function.

The conditions required for $0<D<Y$ are:

$D<Y$ if $\pi p<t$ implies that the taxpayer will declare a taxable income lower than his/her real income if the expected marginal cost of evasion is lower than the marginal tax rate.

$D>0$ if $\pi p>t[\pi+(1-\pi)U'(Y)/U'(Y-tY)]$, where the factor in square brackets is positive and <1. This implies that the taxpayer will declare a taxable income higher than zero if the expected marginal cost of evasion is greater than the marginal tax-rate.

The results of the comparative static are evaluated using the measures of absolute and relative risk-aversion defined by Arrow (1970) as the second derivative of the utility function normalised to the first derivative:

$$Y_A(H) = -U''(H)/U'(H)$$

$$Y_Y(H) = -[U''(H)/U'(H)]H$$

It can be shown that concavity of the utility function implies risk-aversion: corresponding to an increase in concavity, therefore, is a higher degree of risk-aversion.

One must now establish how the income declared depends on the parameters of the model, Y, t, p, π:

$\partial X/\partial Y$, i.e. how declared income varies according to a change in real income. When real income changes, the fraction of income declared does not have a particular sign except under certain restrictions:

$\partial X/\partial Y>0$ if

1) $p\geq 1$ confiscatory sanction, i.e. with an absolute value greater than the amount of tax evaded;

2) absolute risk-aversion decreasing in ratio to income (in that a wealthier individual is deemed better able to sustain the negative consequences of assuming risk).

$\partial(X/Y)/\partial Y$, i.e. how the fraction of income declared varies with a change in taxable income. When real taxable income varies, the fraction declared increases, remains constant or decreases according to whether risk-aversion is an increasing, constant or decreasing function of income.

- $\partial X/\partial t$, i.e. how declared income varies with a change in the tax rate. If the tax rate increases, the taxpayer is influenced by two conflicting considerations:

- a negative substitution effect because an increase in the tax rate makes evasion more economically convenient.
- a positive income effect: an increase in the tax rate pushes the taxpayer towards lower income levels, and given that absolute risk-aversion decreases with an increase in income, the evasion diminishes.

Therefore, when the tax rate increases, evasion increases or decreases according to whether the income effect or the substitution effect prevails.

- $\partial X/\partial p$, i.e. how declared income varies with a change in the penalty tax-rate. An increase in this rate always pushes declared income up and therefore has a deterrent effect on evasion.
- $\partial X/\partial \pi$, i.e. how declared income varies with the probability of audits being made. An increase in this probability will induce the taxpayer to increase the amount of income declared and therefore has a deterrent effect on evasion.

Variations in the penalty tax-rate (p) and in the likelihood of assessment (π) are highly effective in curbing tax evasion. The former is a parameter over which the tax authorities exert direct control, whereas the latter is indirectly controlled by the tax authorities via the amount and efficiency of the resources spent on detecting tax evasion.

Variations in real income and increases in the tax rate do not have a significant effect on the fraction of income declared. In Alligham and Sandmo's model, evaluation of the influence of an increase in the tax rate is indeterminate because two effects of opposite sign operate: a positive income effect and a negative substitution effect. In order to overcome this indeterminacy, Yitzhaki (1974) introduces the following hypothesis into Alligham and Sandmo's model:

- (H_Y1) the sanction is commensurate with the unpaid taxes and not to the undeclared income as in Alligham and Sandmo's model.

The utility function that the taxpayer maximises is therefore the following:

$$E(U) = (1-\pi)U(Y-tX) + \pi U[(Y-tX-m[t(Y-X)]]$$

On the basis of the first- and second-order conditions for the existence of a maximum, it can be shown that if the evasion assessed is punished with a fine equal to m[a(Y-X)], with m>1, the substitution effect disappears because if the tax rate increases, so too does the price of a true declaration, but also that of evasion. Therefore, even if $m=p/t$, i.e. even if the sanction is equal to that in Alligham and Sandmo's model, one obtains $\partial X/\partial t>0$. The taxpayer finds that the additional benefits produced by the decision to evade are annulled. There remain only the effects produced by the taxpayer's changed attitude to risk: a heavier fiscal burden induces the taxpayer to increase the amount declared because, now that s/he has a lower disposable income, s/he is less willing to accept the risks of assessment.

Yitzhaki also shows that, retaining the hypothesis of decreasing risk-aversion, $\partial X/\partial Y<1$, i.e. declared income changes more slowly than taxable income. Individuals with higher incomes tend to evade to a proportionally lesser extent. As taxable income increases, in fact, the sanction commensurate to the evasion diminishes the tendency of the wealthy to reduce the absolute value of the sum not declared to the tax authorities.

Once again starting from Alligham and Sandmo's model, Srinivasan (1973) has developed a third model, the distinctive feature of which is that it introduces risk-neutrality. Specifically, the hypotheses of the model are:

- (H_s1), a progressive tax function [$t=t(X)$];
- (H_s2), a sanction for evasion equal to [$t(Y-X)+P$] (with $P=p(k)$), i.e. an increasing positive function of the amount of undeclared income);
- (H_s3), risk-neutrality (which makes use of the expected utility function superfluous, and the expected income function E(Y) more appropriate).

In formal terms the income function that the taxpayer maximises is the following:

$$E(Y) = (1-\pi)H + \pi(Z)$$
$$E(Y) = (1-\pi)[Y-t(X)X] + \pi[Y-t(Y)Y-p(k)kY]$$

Differentiating this function with respect to the percentage of undeclared income yields:

$$\partial E(Y)/\partial k = -\pi[p(k)Y + kYp'(k)] + (1-\pi)[t'(X)XY+t(X)Y] = f(k,Y,\pi)$$

It can be shown that: $f(0,Y,\pi) > 0$, $f(1,Y,\pi) < 0$; that is, there exists an optimum value of k, between 0 and 1, which maximises the E(Y), denoted by $k°$.

The relations between this value of k° and the parameters Y and π are the following:

- $\partial k^\circ/\partial Y > 0$, i.e. the wealthier the taxpayer, the greater the percentage of income undeclared. This result cannot be obtained with a decreasing positive income utility function, i.e. with risk-aversion.
- $\partial k^\circ/\partial \pi < 0$, i.e. the likelihood of assessment has a deterrent effect on evasion.

Note that in this model the fine does not vary according to the amount of unpaid tax. Therefore two evaders with different incomes but with the same amounts of undeclared income, if discovered, will be treated in the same way.

Fishburn (1979) re-elaborates the three previous models to explore one particular feature: the penalty threshold above which taxpayers will maintain evasion at a minimum level. For this purpose, and starting from the first-order conditions of the expected utility maximisation function of Alligham and Sandmo's model, Fishman expresses the value of s as a function of π, Y, k: that is, as a function of the likelihood of assessment, of income, and of the percentage of income undeclared:

$p(\pi,Y,k) = [\pi t U'(Z) + t(1-\pi)U'(H)]/\pi U'(Z)$

Setting the desired value of k, it is possible to find the corresponding value of p, i.e. p^*.

The same operation is performed with the first-order condition of Yitzhaki's utility maximisation function and with Srinivasan's income maximisation function. It can be shown that in all three functions:

- given k and Y, p^* decreases with respect to π;
- given π and Y, p^* decreases with respect to k;
- given π, with $k=0$, p^* increases with respect to Y if the tax is progressive.

Comparing the three prohibitive levels, one finds that, π, Y, k remaining equal, the value of p^* in Srinivasan's model is lower than the corresponding value in Alligham and Sandmo's model, and that the latter is lower than the value of p^* in Yitzhaki's.

Thus the deterrent effect of a sanction that is an increasing function of the percentage of income not declared is greater than that of sanctions proportional to undeclared income or to evaded tax.

On the basis of Alligham and Sandmo's model, Yaniv (1994) conducts further analysis of the effects on declared income of a variation in the tax rate. For this purpose he introduces the following hypotheses:

- ($H_{YA}1$): the worst thing that can happen to a discovered evader is the confiscation of his/her entire undeclared income;
- ($H_{YA}2$): the taxpayer's relative risk-aversion is constant and its upper limit is the inverse of the penalty tax-rate.

We saw in Alligham and Sandmo's model that the taxpayer's reaction to a variation in the tax rate (a) is given by:

$$\partial X/\partial p = -1/D(1-\pi)U'(H)\{aX[R_A(Z)-Y_A(H)]-(p/p-t)\}, \tag{*}$$

where D is the second-order condition for maximisation of the expected utility function and $R_A(I) = -U''(I)/U'(I) > 0$ is the Arrow-Pratt measure of absolute risk-aversion, with $I = H,Z$.

As already shown by Alligham and Sandmo, in the presence of decreasing absolute risk-aversion $[Y_A(Z) > Y_A(H)]$, the significance of (*) is ambiguous. Introducing the hypothesis of constant relative risk-aversion $[Y_A(I)I = c]$, one obtains that:

$$\partial X/\partial t >< 0 \quad \text{if} \quad ct(H-Z/HZ) >< (p/p-t),$$

$$\partial X/\partial t >< 0 \quad \text{if} \quad c >< \alpha[1+(\beta Y/X)],$$

where $\alpha = (Y-tX)/t(Y-X)$; and $\beta = (1-p)/(p-t)$, with $\alpha > 1$ e $\beta \neq 0$ if $p \neq 1$.

Therefore $p \leq 1$ ensures that $\alpha(1+\beta) > 1$, with $\partial X/\partial t < 0$ if $c \leq 1$.

Since β varies inversely to p, the following restrictions must be imposed on p and on c: If $p \leq 1$ and $c \leq 1/p$ then $\partial X/\partial t < 0$, i.e. there is a significant and negative relation between declared income and the tax rate.

Allingham and Sandmo's Dynamic model

In the second part of their article, Alligham and Sandmo hypothesise that the tax authorities conduct their assessments randomly, as in the above models; but if they discover an untruthful declaration they will check the taxpayer's past behaviour until they find a truthful declaration. A taxpayer who has successfully evaded for a first time, will be subject in later periods to a fine commensurate with any undeclared income in those periods and in previous ones.

To formalise the model the following hypotheses are made:

- ($HD_{AS}1$), in any period (τ) an individual possesses a fixed income which for convenience is normalised to one;
- ($HD_{AS}2$), let π be the fixed probability that s/he will be investigated in period τ;
- ($HD_{AS}3$), if in period τ it is discovered that s/he has undeclared his/her income, then his/her past declarations are checked until a truthful one is found;
- ($HD_{AS}4$), in every period τ the amount of income (X_τ) that s/he can declare lies within the interval $0 \leq X_\tau \leq 1$.

At time τ two situations may arise:

1) the individual is not investigated and his/her income after payment of taxes is $H_\tau = 1 - tX_\tau$;

2) the individual is investigated and his/her income after payment of taxes is $Z_\tau = 1 - tX_\tau - \pi\Sigma(1-X_\tau)$.

In formal terms the taxpayer maximises the definite expected utility as:

$$E(U_\tau) = (1-\pi)U(H_\tau) + \pi U(Z_\tau)$$

On the basis of the first- and second-order conditions for the existence of a maximum, the taxpayer may behave in two different ways:

- The taxpayer evades as long as $\partial E(U_\tau)/\partial(1-X_\tau) > 0$, i.e. as long as the loss of expected utility due to the sanction is less than the increase due to the tax evaded. However, in order to prevent the sanction from increasing because previous evasion has gone unpunished, the evader will evade progressively less and X_τ will increase over time. When $\partial E(U_\tau)/\partial(1-X_\tau) < 0$, his/her declaration becomes truthful. In the following period it will still be convenient for the taxpayer to evade, because any checks on his/her declarations will go no further back than the period in which $X_\tau = 1$.
- The taxpayer will seek to maximise the amount of expected utility across a certain time-span. In this case too, the taxpayer will evade increasingly less over time and there will be periods in which $X_\tau = 1$.

Declared income X_t will always be higher if the taxpayer adopts the latter form of behaviour than if s/he adopts the former. Moreover, there are two features to be stressed here:

a) the likelihood of checks being made is assumed to be constant over time; the taxpayer is therefore indifferent to whether the evasion is discovered in the current period or in following ones;
b) the presence of inflation reduces the real amount of the penalty over time, because no efficient mechanism exists for indexing the penalty for past evasion.

2.1.2 Models of the discontented taxpayer

This second group of theoretical contributions to the study of tax evasion introduces an important novelty, in that they examine the psychological or moral factors that may have an effect on taxpayer behaviour. The reasons for taxpayer discontent can be listed as follows:

- the taxpayer believes the tax laws to be unfair or applied unfairly;
- the taxpayer believes that the ratio between the sacrifice required of him/her in paying taxes and the benefit received in return from the government is too high, or s/he wants public services different from those actually delivered;
- the taxpayer regards his/her tax burden to be excessive,
- the taxpayer views the tax laws to be too complex, badly formulated, obscure, difficult to obey, uncertain and changeable.

I shall now examine how discontent may lead to tax evasion in terms of models which concentrate on subjective elements in taxpayer behaviour. The first model was developed by Strumpel (1969), who maintained that willingness to cooperate with the tax authorities is a variable which determines the taxpayer's behaviour. It exerts a positive influence on the declaration of incomes and depends on various factors:

1) rigidity of the tax system (severity of the laws, efficacy of sanctions, methods of assessing the tax base) which influences the application of tax laws positively but has a negative influence on the willingness to cooperate with the tax authorities;

2) the gap between the tax laws and reality (the inequitable application of the laws) negatively influences both the application of the tax laws and willingness to cooperate with the tax authorities;
3) difficulty of formal compliance with the tax laws, which has a positive influence on their application because the taxpayer is obliged to cooperate with the tax authorities in order to cope with the uncertainty or complexity of the laws.

A second model has been proposed by Chung (1976), who bases his analysis on the following proposition: "an individual is not only interested in his/her own welfare, but also in the welfare of society as a whole." Chung proposes a model in which an individual attributes a positive value to whatever may increase the welfare of society (for example the transfer of income to the less well-off). But the discovery of wastage, abuses or inefficiencies in the use of public money progressively decreases the optimum burden that the taxpayer finds tolerable.

Given the individual's concern for the welfare of the entire system, in formal terms the welfare function can be written as follows:

$$W=W(x,\ell) \qquad [2.1]$$

where W is welfare, x is the amount of income deducted from an individual and ℓ is the amount of income transferred to society to enhance social well-being.

Expanding the equation in a Taylor series and retaining the linear terms, one obtains:

$$W(x,\ell)-W(x_0,\ell_0)=W_x(x-x_0)+W_\ell(\ell-\ell_0) \qquad [2.2]$$

where x_0, ℓ_0 respectively denote the income deducted and transferred prior to the transfer ($\ell_0=0$); W_x is the marginal utility of the income deducted and W_ℓ is the marginal utility of the income transferred to the government; $W_\ell>0$ represents an individual's concern for the welfare of the system.

Equation [2.2] shows that a transfer of income to society for the enhancement of social well-being improves individual welfare if:

$$W(x,\ell)-W(x_{0,}\ \ell_0)>0 \qquad [2.3]$$

Equation [2.3] is valid if $W_\ell > W_x$, i.e. if the utility of the income transferred is greater than the utility of the income deducted. Assuming that one dollar transferred to society is spent on social welfare, an individual's budget function is the following:

$$Z = Z(x,\ell) = x+\ell \qquad [2.4]$$

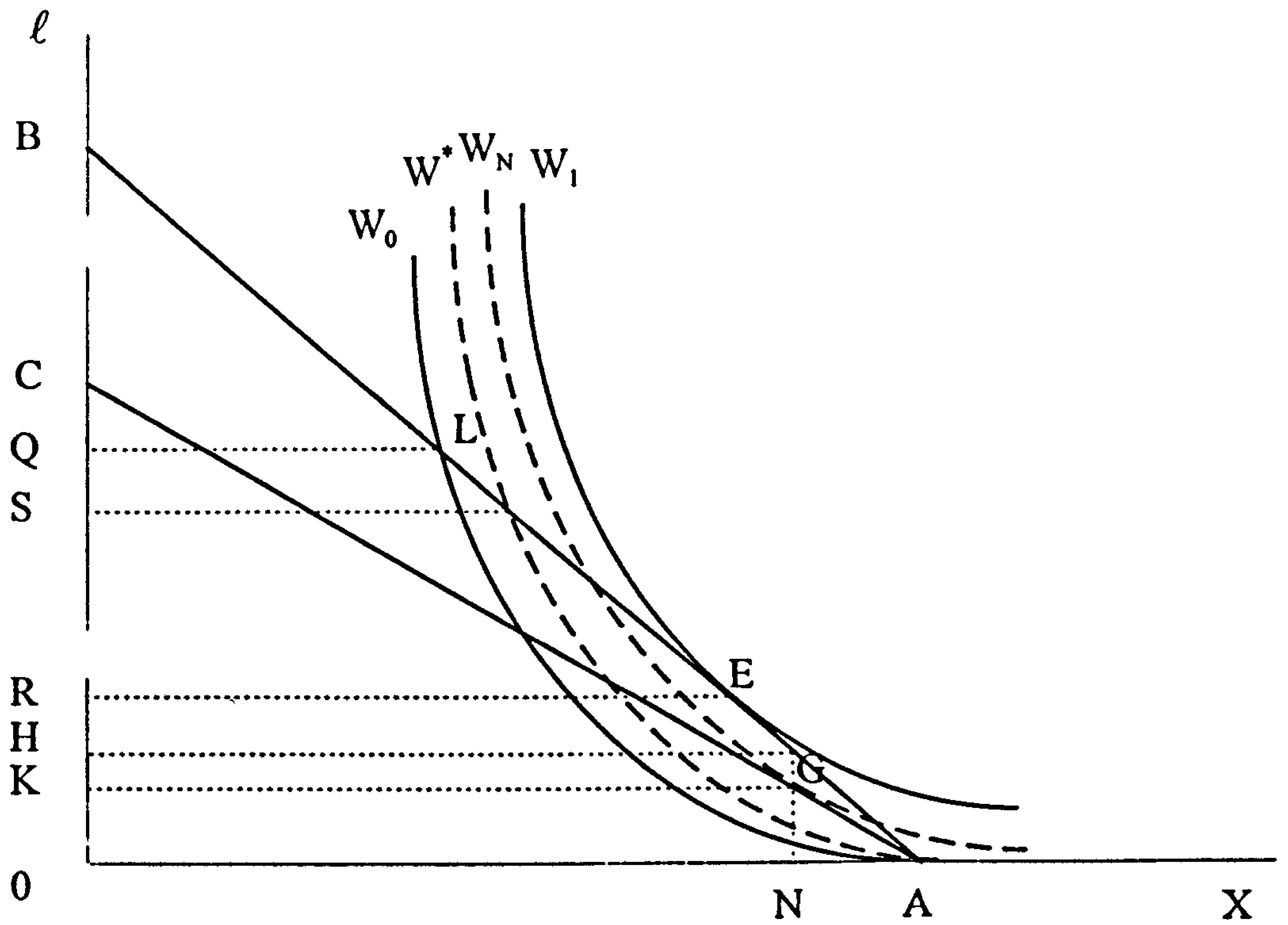
with slope $\ell'(x) = -1$. Equation [2.4] is represented by the straight line AB in figure 2.1.

The combination of x and ℓ that maximises equation [2.1] is obtained from the first-order condition:

$$W_x/W_\ell = 1$$

This is represented by the point of tangency E between the indifference curve W_1 W_1 and the budget straight line AB (OM, OR). The optimal level of transfers is OR, where an individual's marginal benefit obtained from enhanced social welfare is equal to the marginal benefit obtained from his/her consumption/saving of the income deducted. In this situation an individual can tolerate transfers of income up to OQ. In fact, point L corresponding to the transfer OQ lies on the same level-curve as point A, which is the point at which the income transferred is equal to zero. Therefore, when transfers lie between OR and OQ, the individual is satisfied. That is to say, at these points the benefit obtained by the individual from the realisation of social welfare is the same as the benefit that s/he receives from consuming/saving the same amount of income.

Fig. 2.1 The Chung model



Source: Chung P. (1976) p. 127

Government institutions organise the levying of transfers from individuals and their allocation to society. This may lead to wastage and the onset of abuses, corruption, poor administration, etc. This wastage engenders the following variation in the individual's budget function:

$$Z = x + \ell + q(\ell)$$

with a slope equal to: $y'(x) = -1/[1+q'(\ell)]$

where q is the level of waste, which is an increasing function of the income transferred to society, $q = q(\ell), q'(\ell) > 0$.

Since $q'(\ell) > 0$ then $\ell'(x) = -1/[1+q'(\ell)] > -1$, i.e. the budget straight line is no longer represented by the line AB but by the line AC, in that a proportion of the money transferred to society is wasted.

Given that the individual is concerned to enhance social welfare, the presence of wastage also alters his/her social welfare function, which becomes:

$$W = W[x,\ell,q(\ell)]$$

where $W_q < 0$ represents the marginal disutility of waste.

The presence of $q(\ell)$ shifts the indifference curve towards the right (W*W*), which is a situation in which the individual is less willing to abandon x for ℓ. The optimum level of transfers in the presence of waste is OH, of which OK goes on social welfare and KH on wastage. The upper limit on the level of tolerance also reduces, from OQ to OS. The periodic discovery of widespread and serious squandering of public money progressively reduces the optimum acceptable tax burden.

The Chung model designs a taxpayer that takes her/his decisions by remaining within a strict individualistic dimension. The decision to evade is actually built on a selfish calculus that relates the tax payer's utility from private consumption to utility, always measured on a individual basis, derived from some form of not very clearly defined "social well-being". Put in this way the theoretical framework is less innovative that it might seem because it becomes a problem of choice between two different kind of goods: "private consumption" versus "social well-being".

Nevertheless, Chung's analysis teaches some interesting lessons, not only from a theoretical perspective but also as regards experiments on tax evasion. The most important lesson concerns the delicate relationship between a taxpayer's behaviour and his/her perception of the 'good' use made of public money. A badly designed experiment can produce distortions due to uncontrolled expectations made by the experimental subjects about the use of the money paid for taxes. Unless the experiment has the explicit objective of investigating this phenomenon, the best way to avoid uncontrolled reactions is to inform subjects in the clearest possible way about the use that will be made of the money collected through taxes. What really matters is not finding a fair use of the money, but giving explicit information about its destination. This is to ensure the interpretation of results from unknown subjective assumptions made by the experimental subjects about this important part of the experiment.

Becker and Spicer (1980) have proposed a further model, which analyses the exchange relation between the taxpayer and the government. The taxpayer/government relationship is viewed as an exchange relation in which the taxpayer relinquishes part of his/her purchasing power in the private market in exchange for the benefits that s/he obtains from the goods and services furnished by the government.

Research in social psychology suggests that an important factor determining personal satisfaction with an exchange relation is the reaching of parity or equity in the exchange. The socio-psychological theory of equity developed by Adams (1965) contends that an unequal relation may produce tension or a sense of disquiet such to induce the person concerned to eliminate it. If this theory is extended to the taxpayer/government relation, tax evasion can be viewed as a means whereby the taxpayer seeks to restore equity to his/her exchange with the state. In particular, taxpayers (victims) who believe that they are treated unfairly will change the amount paid to the revenue system, increasing the amount of income evaded, while taxpayers (beneficiaries) who believe that the presence of inequalities is beneficial to them will not resort to tax evasion.

2.2 Prospect theory

As said earlier, for many years the economic analysis of decisions in conditions of uncertainty was based on the theory of expected utility originally formulated by von Neumann and Morgenstern (1947). In recent years, however, numerous authors have pointed out the shortcomings of this theory, both as a prescriptive model of optimising behaviour in situations of uncertainty, and as a descriptive model claiming to represent how individuals take decisions in reality. In particular, the majority of the empirical studies that have set out to verify whether individuals actually behave in the manner hypothesised by the theory have shown that they act in ways that conflict with its axioms.

The empirical evidence shows that these axioms are systematically violated in certain classes of choice problem, and that certain choice phenomena contrast with the theory of expected utility:

1. *composition effect.* The theory of expected utility presumes that the description is invariant, which implies that equivalent formulations of a choice problem will yield the same order of preferences.
2. Conflicting with this assumption is the evidence that variations in the composition of choices systematically produces different preferences. It has been shown that the formulation of the same problem in terms of gains or in terms of losses predictably leads to different choices being made. In fact , depending on whether a problem is described in terms of gain or loss, risk-aversion or risk-search will ensue.
3. *Non-linearity of preferences.* The theory of expected utility presumes that the utility of a risky prospect is linear with the likelihood of its consequences x_i: $U(x_1,\pi_1; x_2,\pi_2,\ldots\ldots, x_n,\pi_n) = \pi_1 u(x_1)+\pi_2 u(x_2)+\ldots\ldots\ldots+\pi_n u(x_n)$, i.e. the utility of a prospect is equal to the expected utility of its consequences.
4. The evidence shows that the utility of a risky prospect depends not only on the probability of its occurrence but also on the desirability of its consequences: the difference between a gain of £50 and £100 has greater subjective value than the difference between a gain of £1050 and £1100.
5. *Source dependence.* The readiness of people to gamble on an uncertain event does not depend only on the degree of uncertainty; it also depends on its source. People prefer to gamble on a prospect whose characteristics are known to them. The evidence suggests that people often prefer to gamble on a prospect within their area of competence even if its probability is unclear.
6. *Risk-search.* An important assumption of the theory of expected utility is that the decision-maker is risk-averse. There is evidence, however, that decision-makers may seek out risk in two classes of decision problems:
   - when the decision-maker must choose between a certain loss and the substantial probability of a greater loss;
   - when the decision-maker must choose between the low probability of obtaining a large reward and the expected value of the prospect.
7. *Loss aversion.* One of the phenomena at the basis of choice in conditions of uncertainty is that losses generally appear at a distance to be greater than the corresponding gains. Thus a loss of X pounds is more undesirable than a gain of X pounds is attractive, i.e. $u(£X)<-u(-£X)$.

In the light of these observations at odds with the theory of expected utility, Tversky and Kahneman (1979) have proposed an alternative theory of choice in conditions of uncertainty. Known as *prospect theory*, this approach has been developed for simple prospects with monetary consequences and specific probabilities, but it can be extended to more complex choices. The theory envisages two stages in the decision-making process:

a) editing, which consists in preliminary analysis of the prospects offered and often produces a simpler representation of them. Various operations are performed which transform the consequences and probabilities associated with the prospects offered.
b) evaluation: the decision-maker evaluates each of the prospects and chooses the one of greater value.

The overall value of a prospect, denoted by V, is expressed in terms of two scales, φ and v.

- φ → associates with each probability π a decision weight $\varphi(\pi)$ which reflects the impact of π on the overall value of the prospect.. It is not a measure of probability: in fact, $\varphi(\pi) + \varphi(1-\pi)$ is a value lower than 1, but the decision-weight which measures the impact of events on the desirability of the prospect, and not just the perceived probability of these events.
- V→ assigns to each consequence x_i a number $v(x)$ which reflects the subjective value of the consequence. Consequences are defined in terms of deviation from point zero on the value scale. Thus v measures the value of deviation from this point; that is, it measures gains and losses.

Consider a simple prospect of the form $(x, \pi; y)$ where x is received with probability π; y with probability q, and nothing with probability $(1-\pi-q)$, where $\pi+q \leq 1$.

This prospect may be of three types:

1. strictly positive if its consequences are all positive, i.e. $x,y>0$ and $\pi+q = 1$;
2. strictly negative if its consequences are all negative, i.e. $x,y<0$ and $\pi+q = 1$;
3. regular when it is neither strictly positive nor strictly negative, i.e. $x \geq 0 \geq y$ or $x \leq 0 \leq y$ and $\pi+q<1$.

If $(x,\pi;y,q)$ is a regular prospect, then its evaluation is described by the following equation:

$$V(x,\varphi;\ y,q)=\pi(\varphi)v(x)+\pi(q)v(y) \qquad [2..5]$$

where $v(0) = 0$, $\pi(0) = 0$, $\pi(1) = 1$.

V is definite on the prospects and v on the consequences. The two scales coincide for certain prospects, where $V(x,1) = V(x) = v(x)$.

V is definite on the prospects and v on the consequences. The two scales coincide for certain prospects, where $V(x,1) = V(x) = v(x)$.

Equation [2.5] generalises the theory of expected utility by attenuating the expectation principle.

- If $(x,\pi;\ y,q)$ is a strictly positive or strictly negative prospect, then its evaluation is described by the following equation.

If $\pi+q = 1$ and $x>y>0$ or $x<y<0$, then

$$V(x,\pi;\ y,q)=v(y) + \varphi(\pi)[v(x) - v(y)] \qquad [2.6]$$

The value of the strictly positive or strictly negative prospect is equal to the sum of the following two components:

1. the lesser risk component, i.e. the minimum gain or minimum loss that will be obtained or suffered with certainty;
2. the risk component: the difference-value between the consequences multiplied by the weight associated with the riskier consequence. The additional gain and the additional loss at stake.

Example $V(400, 0{,}25;\ 100, 0{,}75) = v(100) + p(0{,}25)[v(400) - v(100)]$.

The weight of the decision is applied to the difference-value which represents the riskier component.

Note that the left-hand side of [2.6] corresponds to $p(\pi)v(x)+[1-\varphi(\pi)]v(y)$, and therefore equation [2.6] converts into equation [2.5] if φ $\varphi(\pi) + \varphi(1-\pi)=1$.

Now let us assume that the function of the value for wealth changes is normal concave for values above the reference point, i.e. for gains ($v''(x)<0$ for $x>=$) and often convex for values below the point of reference, i.e. for losses ($v''(x)>0$ for $x<0$). That is to say, the marginal value of both gains and losses decreases with their amount. Let us also introduce the principle of loss aversion, which states that losses appear at a distance greater than gains. The negative experience of losing a sum of money is greater that the pleasant experience of gaining the same amount. Hence, if $x>y>0$ then $(y,0.50; -y, 0.50)$ is preferred to $(x, 0.50; -x,0.50)$.

In accordance with equation [2.5]

$$v(y) + v(-y) > v(x) + v(-x) \quad \text{and} \quad v(-y) - v(-x) > v(x) - v(y).$$

Setting $y=0$, one obtains:

$$v(x) < -v(-x) \qquad \text{and} \qquad v'(x) < v'(-x)$$

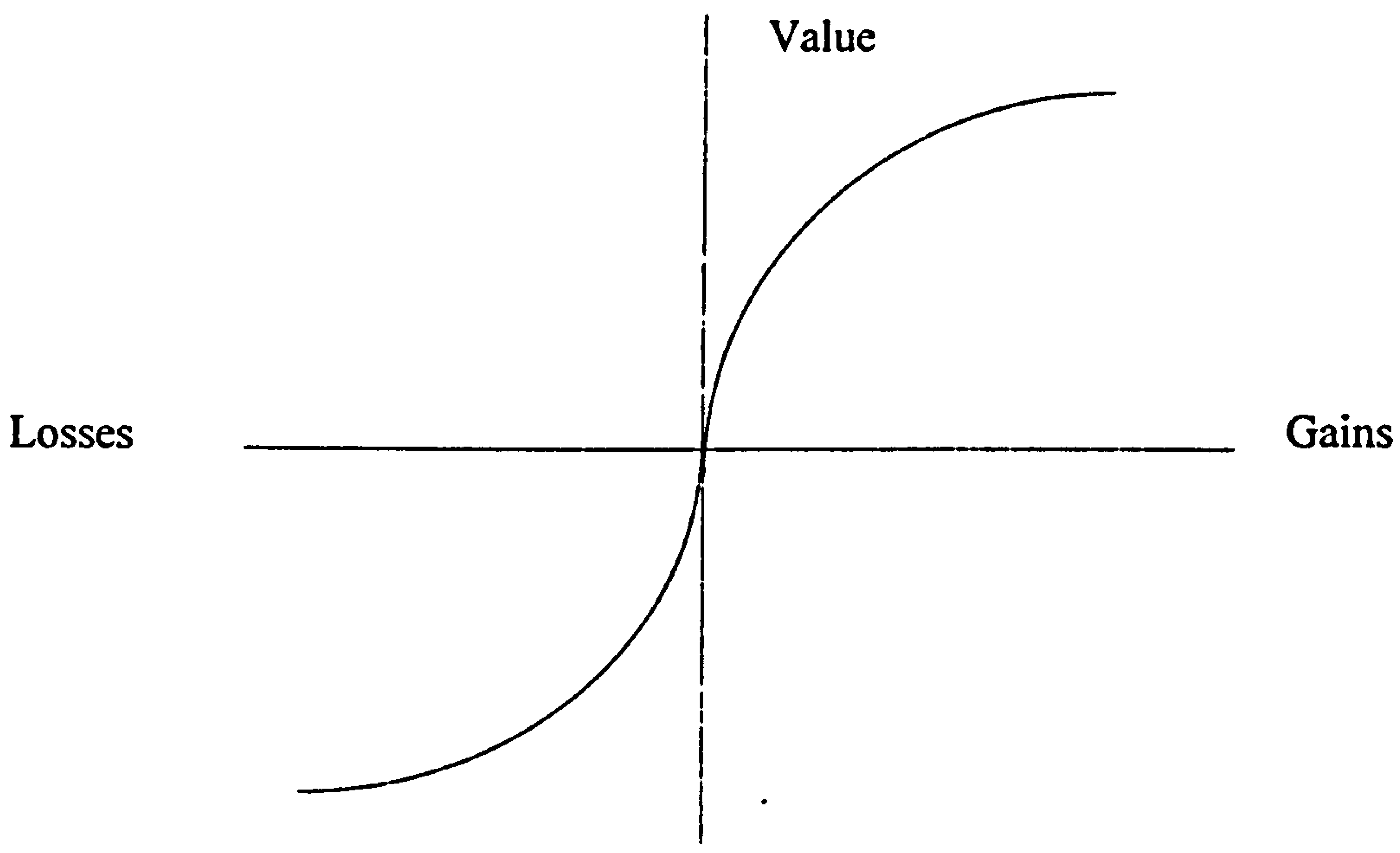
In this way, the function of the value for losses is steeper than that for gains.

By way of summary, according to prospect theory the function of the value has the following three features:

1. It is definite in terms of positive deviations (gains) or negative deviations (losses) from a certain reference point and not in terms of total wealth, this means that the choice of a given reference point is independent from the utility level;
2. Its slope is greater in the quadrant of losses than in the quadrant of gains: it is steeper for losses than for gains. This property, known as *loss-aversion,* implies that the loss of utility associated with forfeiture of a good in our possession is generally much greater than the gain in utility associated with obtaining that good. More generally, loss aversion involves a strong tendency to maintain the previous situation (*status quo*) because the disadvantages of relinquishing it seem greater than the advantages of the alternative option.
3. It is concave for gains (above the reference point) and convex for losses (below the reference point). This property, known as non-linearity of the function, implies that in the domain of gains there is risk aversion ($u''(x)<0$), i.e. the certain prospect (x) is

preferred to a risky prospect with expected value x, while in the domain of losses there is a search for risks (u''(x)>0). One function of the value which satisfies these three characteristics is represented in figure 2.2.

Fig. 2.2 Prospect theory



Source: E. Shafir, A. Tversky, (1980)

Prospect theory can be used to explain tax evasion - more specifically to examine the taxpayer's attitude to risk. In fact, paying taxes may be perceived either as a reduction of profit or as a loss. From the standpoint of prospect theory, it is hypothesised that if payment of taxes is perceived as a reduction of profit then the taxpayer's utility function assumes a concave shape. By contrast, if payment of taxes is perceived as a loss, then the taxpayer's utility function assumes a convex shape.

2.3 Attribution theory

Attribution theory is a psychological approach to the study of social behaviour (Hewstone, 1991). It seeks to identify the causes of the behaviour observed, and it is particularly concerned with how people explain their own behaviour and that of others, and more in general the events of the social world. By 'causal attribution' is meant the psychological process by which, in everyday situations, a person comes to believe that a certain form of behaviour - his/her own behaviour or that of others (hetero- or self-attribution) - is the consequence of particular causes. The concern, therefore, is not the behaviour of others but its causes.

Heider (1958), the first psychologist to study these problems, maintained that the task of so-called common-sense psychology is to understand the way in which people interpret the events of their social world. According to Heider, the fundamental criterion in interpretation of a person's behaviour is whether the cause of the phenomenon lies in the person (inner or dispositional cause), in the environment (external or situational cause), or in both. Heider goes on to stress the importance of the concept of intentionality, arguing that behaviour should be attributed to personal causes only if its consequences are perceived as resulting from the actor's intentions. A compromise is thus reached between the influence of personal and impersonal factors, so that attributions to a person's characteristics are less probable when the behaviour is perceived as governed by external constraints. Personal features (attitudes, needs, beliefs, personality structures) are thus used to explain behaviour that cannot be clearly attributed to external conditions.

This basic approach was systematised and developed by Jones and Davis (1965), by Kelley (1967), and by Jones and Nesbitt (1971), and more recently it has been applied to a variety of economic phenomena, and in particular to tax evasion by Kaplan, Reckers and Reynolds (1986) and by Hite (1987). Kelley investigates what information is used by a person to make a causal attribution and how this information is used. The basic assumption is that individuals tend to weight the various explanations available to explain behaviour by looking for co-variations between presumed causes and effects.

More specifically, in seeking the causes of events that s/he observes, an individual applies three types of information:

1. consensus information, whereby others respond in the same way as individual A to the same entity if placed in the same situation;
2. information on the distinctive character of the effect or behaviour observed, whereby individual A's response to a given entity (B or the environment) is different from his/her response to other entities (C,D);
3. information on coherence, constancy, whereby the behaviour observed is constant over time and from one situation to another.

Specific combinations of these types of information determine whether the behaviour should be attributed to the person, to the circumstances, or to a combination of them. The three criteria regulate the internal/external character of the attribution in the following way:

a) if the behaviour observed is distinctive, constant and consensual, the attribution is external (the behaviour depends on the environment);
b) if the behaviour observed is neither distinctive nor consensual but is constant, the attribution is internal, in that the cause of a person's behaviour lies within him/herself.

Jones and Nisbett concentrate on the so-called divergent perspectives in the attributional activity of observer and agent. Whereas internal attribution is typical of the observer, the agent will have a much more marked tendency to attribute external causes to his/her behaviour. There are various explanations for this:

- motivational explanations, whereby the agent is more concerned than the observer to present a 'de-responsibilized' version of his/her behaviour. This hypothesis is adequate only in negative cases (of failure or of reprehensible behaviour by the actor), while in positive cases it should be reversed;
- more 'cognitive' explanations deriving from examination of the different information on which the observer and agent base their attributions. The agent will presumably have better knowledge of him/herself and of his/her reactions to similar circumstances, whereas the observer tends more towards internal attribution, generalising and typifying the specific behaviour of the agent.

Drawing on the work of these authors, Kaplan, Reckers and Reynolds (1986) and Hite (1987) have applied these theories to tax evasion. Kaplan, Reckers and Reynolds argue that the various principles of attribution theory can be usefully applied in formulating hypotheses on tax evasion and base their discussion on the work of Heider, Davis and Jones, and Kelley. The causes of tax evasion can accordingly be identified as follows:

1. dispositional causes (internal): the taxpayer's lack of social responsibility:
2. situational causes (external): unfairness of the tax system.

The more a person is deemed responsible for his/her actions, the more observers believe that personal characteristics determine behaviour. Kelley's principle of co-variance can be applied in order to establish which type of cause should be attributed to tax evasion. In doing so, authors have analysed the types of information that can be used to predict tax evasion and to suggest punishment for such behaviour:

Hypothesis 1: *information on consensus.* This provides knowledge about the rule governing a particular form of behaviour. It thus describes whether the behaviour of one taxpayer is similar to or different from the behaviour of other taxpayers under similar conditions. In this case authors have tried to identify the social rule and to measure its influence on opinions concerning the percentage of taxpayers who evade. It is expected that a person will be held less responsible if in the same circumstances his/her behaviour is similar to that of other taxpayers, and more responsible when his/her behaviour is different from that of other taxpayers in the same situation.

Hypothesis 2: *information on salience.* This is a summary description of the relations among different situations and their corresponding effects. During their lifetimes, individuals have frequent opportunities to engage in illegal or immoral activities, one of which is tax evasion. High salience emerges when the immoral or illegal behaviour occurs only when the individual has had an opportunity to evade taxes. In this case tax evasion will be attributed mainly to situational causes. Low salience denotes a situation in which the immoral or illegal behaviour always occurs. In this case the tax evasion will be attributed to dispositional causes.

Hypothesis 3: *information on the taxpayer's financial situation.* Severe financial need by the taxpayer can be considered a situational cause, while low financial need can be considered a dispositional cause.

Hypothesis 4: *information on the needs of society*. When society has severe needs, tax evasion appears more abnormal and indicative of the dispositional features of the taxpayer.

Hypothesis 5: *information on the taxpayer's intention*. A pronounced intention to evade will be associated with high external environmental attributions.

Hypothesis 6: the belief that tax evasion is not immoral will be associated with a high intention to evade.

By combining these various forms of information, the following results as regards tax evasion can be obtained:

- attributions made regarding the tax evasion of others will be associated with the individual's tax evasion;
- if an individual believes that tax evasion by someone else has been induced and is justified by situational causes, then it is probable that this individual place in the same circumstances will cite these situational factors in justification of his/her tax evasion.

Hypothesis 5 states that the attributions made for the actions of others will be directly associated with the person's own actions. Authors have concluded that taxpayers believe that it is more acceptable to cheat in situations where persons with high standards have cheated than to follow the behaviour of morally corrupt persons. The apparent implication for attribution theory is that critical external factors act as a morally powerful inducement to cheat.

Hite has based his study on a different aspect of attribution theory, that of the actor/observer difference whereby actors tend to attribute their actions to external situational causes while observers tend to attribute the actions of others to dispositional causes. Applied to tax evasion, this difference implies that individuals believe that their own evasion is caused by too high tax rates while other people's evasion depends on dispositional causes.

2.4 Survey of the experimental literature: a taxonomy

In previous sections of this chapter I have shown how the problem of tax evasion has been addressed from the theoretical point of view. That is to say, I have identified a series of theories which frame taxpayer behaviour in both economic and psychological terms. The robustness of the theories here described should be tested by using empirical data. As anticipated in the preface good data about fiscal evasion are difficult to collect because to evade taxes is a crime; therefore, the experimental approach is probably the best way to verify theories about fiscal evasion.

A number of researchers have insisted that consideration should be made not only of economic factors, like the tax rate and the probability of assessment and punishment, but also of non-economic factors, in order to orient research towards a more general and more realistic theory of taxpayer behaviour. These non-economic factors (age, income, moral beliefs, the equity of the tax system, etc.) are analysed using an experimental approach based on artificial simulations. The general idea behind laboratory simulations organised to study taxpayer behaviour is relatively simple. By means of specially designed experiments in which the subjects are asked to decide within a certain time-interval what percentage of a hypothetical income they intend to declare, it is possible to verify how various items of information given to them during the experiment affect their decision-making processes.

In this chapter I shall examine experimental work on tax evasion. In order to facilitate discussion of these experiments I begin by providing a taxonomic grid which will give coherent organisation to the analysis that follows.

I have decided to classify the experiments on tax evasion on the basis of two criteria:
(1) according to the variables that they examine:

- group A: the relationship between fines, problems of investigation, income, public transfers and evasion,
- group B: tax equity,
- group C: explanations given by the experimental subjects,
- group D: imitation among evaders,

(2) according to theories that they consider:

I. utility theory

II. prospect theory

III. attribution theory

IV equity models

In the previous sections I discussed the theoretical approaches to tax evasion. Only one theory shown in the above taxonomic grid has not yet been discussed: the so called "equity model" or equity theory approach. I have not included this approach in the theoretical review because it does not take the form of a real theory. In fact equity models resemble more a body of empirical studies concerned with the role played by mechanisms of psychological self-enforcement of rules and laws than a structured theory. Many authors (e.g. Adams, 1965; Thibaudt, Friedland, Walker, 1974), starting from empirical observations, have reached the conclusion that the degree of compliance with the rules is influenced by the perceived "fairness" of the rules themselves. More precisely, these psychological devices of self-restraint seemed strongly correlated with the nature of the exchange relationships between the agents. In the specific case of tax evasion the exchange is between the tax-payer and the state, and therefore the degree of effectiveness of the mechanism of individual self-restraint fails when the tax-system becomes too oppressive, i.e. when it is perceived as unfair. In the theoretical model that I have used to build the experiments discussed here, the central idea embodied in the equity models has in some way been recovered, but it has been inserted into a more rigorous microeconomic theory frame.

Table 2.1, which provides a cross-referenced representation of the two classifications suggested for the taxonomic grid, shows that certain experiments analyse two opposing theories in order to verify whether the taxpayer's actual choices correspond to one theory or to the other. In group A, for example, many authors analyse both utility theory and prospect theory in order to falsify the one with respect to the other. In the same way, in group B, Kaplan, Reckers and Reynolds analyse both attribution theory and equity theory.

It is worth stressing that many of the experiments reported in table 2.1 aim to test specific parts of the theories from which they start. More precisely, experiments on tax evasion are mainly intended to check the existence of some form of relationship between a more or less large set of theoretical factors and the decision to evade. None of the experiments discussed here tries to suggest a brand-new theory about taxpayer behaviour deduced from the empirical data obtained from the experiments. The experiments run with a more pronounced 'exploratory' aim are those belonging to groups B and C, but they do not reach any strong (formalised) theoretical conclusion and remain only at a descriptive level.

This limit of the experimental approach to fiscal evasion is partly due to the high degree of complexity that the decision to evade taxes can imply. The number and nature of the psychological and moral factors that may influence the decision to evade is evidenced by the descriptive part of the experiments belonging to group B and C. These experiments, as will be discussed in detail in the following sections, show that the experimental subjects take a large number of 'built-in' ideas about taxes and fiscal fairness with them into the experiment. To isolate these factors from those explicitly considered by the experiment is almost impossible, not only because they are part of the so-called "central value system" of each subject, but also because they are very complex.

Among the psychological elements reported by experiments (e.g. Spicer, Becker 1980) certainly one of the most interesting is that of the psychological mechanism used by the subject to build their subjective range of tax fairness. This psychological device is apparently built on a comparative basis. The subjects need to compare their individual position with that of the other taxpayers and considerations about the relationship between the amount of taxes paid and the amount of public services received seems to be of minor importance unless it is referred to a comparative landscape.

Given the large number of experiments on tax evasion and for the sake of brevity and clarity, I shall not discuss every essay reported in table 2.1. Instead, I shall confine my comments to the main results obtained for each group of experiments, from which I shall also discuss in detail one or two papers particularly closely related to the experiments that I have carried out and which I shall discuss in the following chapters.

Table 2.1 Experiments divided into homogeneous categories

Group A, the relationship between fines, investigation, income, public transfers and evasion

	Utility theory	Prospect theory	Attribution theory	Equity models
A1) N. Friedland, S. Maital, A. Rutenberg, 1978	X			
A2) M. W. Spicer, J. E. Thomas, 1982	X			
A3) N. Friedland, 1982				
A4) O. H. Chang, D. R. Nichols, J. J. Schultz 1987	X	X		
A5) J. C. Baldry 1985	X			
A6) W. Becker, H. J. Buchner, S. Sleeking, 1987	X			
A7) J. Alm, G. H. McClelland, W. D. Schulze, 1992	X	X		
A8) J. Alm, B. R. Jackson, M. McKee, 1992	X			
A9) Y. Benjamini, S. Maital, 1985	X			
A10) J. C. Baldry, 1986	X			
A11) P. Webley, S. Halstead, 1986	X			
A12) P. Webley, I. Morris, F. Amstutz 1985	X			
Group B, tax equity				
B1) M. W. Spicer, L. A. Becker, 1980				X
B2) S. E. Kaplan, P. M. J. Reckers, K. D. Reynolds, 1986			X	X
B3) P. A. Hite, 1990				X
B4) H. S.J. Robben, P. Webley, R. H. Weigel,.K. Warneryd, 1990		X		
Group C, explanations given by the experimental subjects				
C1) S. E. Kaplan, P. M. J. Reckers,1985				X
C2) P. A. Hite, 1987			X	
C3) Q. Thurman, 1988			X	
Group D, imitation among evaders				
D1) M. W. Spicer, R. E. Hero, 1985	X			
D2) S. E. Kaplan, P. M. J. Reckers, S. J. Roark, 1988		X		

2.4.1 Group A: the relationship between fines, problems of investigation, income, public transfers and evasion

The experiments belonging to the first group are particularly important because they yield interesting insights into the role played by all the factors suggested by the microeconomic theory. The main results obtained from these experiments have been summarised in table 2.2, in which the first group of columns show the nature of the relationship between the factors analysed by experiments and the frequency of evasion (and/or the amount of money evaded). The second part of the table reports the degree of coherence between the results and two theories: expected utility theory and prospect theory.

Table 2.2 Relationships between tax evasion and some influencing factors

Exp.	Theories		Nature of the correlation with factors					
	Utility theory	Prospect theory	Gross Income	Government transfers	Socio-economic	Audit probability	Fines	Tax rate
A1	confirmed				absent			
A2	confirmed					negative strong		
A3	confirmed					negative strong	negative weak	
A4		confirmed						
A5	partially invalidated							positive
A6			positive	negative		negative		
A7	partially invalidated	partially confirmed						
A8	partially invalidated		positive	positive		negative	positive weak	negative
A9	partially invalidated		positive low		partial	negative low		positive strong
A10	confirmed							
A11	partially invalidated					negative strong	negative weak	
A12	partially invalidated					negative strong	negative weak	

Before discussing table 2.2, it should be stressed that any comparison among the experiments must be made with great caution, because the experimental designs are often so different as to make immediate comparison between the results impossible. Nevertheless, in my opinion, some comparative deductions are legitimate because most of the works explicitly refer to previous experiments.

The first observation that emerges from analysis of table 2.2 concerns the close coherence among the results obtained from the majority of the experiments on the role played by audit probability and fines. Audit probability is always negatively correlated with the frequency of evasion and with the amount of money evaded; in many experiments this correlation is extremely close. On the other hand, the amount of fines seems to be much less influential than the frequency of tax audits. More precisely, numerous experiments report that the importance of fines is extremely low on its own, that is, when it is not reinforced by a simultaneous increase in the probability of discovery. The extreme and apparently irrational result concerning this phenomenon is reported by experiment A8, which found a (very weak) positive correlation between fines and evasion when audit probability was left unchanged.

After audit probability and fines, the only factor shown to produce identical effects in all the experiments is gross income. The correlation is always positive, and therefore - assuming that the individual propensity towards risk does not change during the experiment, and keeping both fines and audit probability constant - it seems that this relationship signals a phenomenon of decreasing marginal utility of money, which is in accordance with the usual assumptions made by utility theory. In fact, if the expected monetary value of an additional pound does not change and the attitude towards risk remains constant, then, in accordance with expected utility theory, at higher levels of income tax evasion should decrease, because the utility of an additional sure pound should be lower than the utility of a sure pound at low levels of income. Assuming that U_l is the additional utility that a taxpayer obtains from a pound of additional income and hypothesising decreasing marginal utility of money, we have:

$$U_l^{\ell} > U_l^{h}$$

where U_1^l is the additional utility obtainable from one sure additional pound when the income is low, and U_1^h is the additional utility obtainable from one sure additional pound when the income is high. Assuming for sake of simplicity that a low income tax payer *j* with a gross income of 2 pounds can choose between the following alternatives:

a) earn a sure net income of 1 pound by paying 1 pound of taxes;
b) evade the entire gross income by taking the risk of being audited with probability 0.5 and therefore of paying 1 pound of tax plus 1 pound of fee.

Given these alternatives the expected monetary value of a pound evaded is $EV_1 = 1$ pound (i.e. the taxpayer is confronted by a fair gamble). Therefore if we observe that the taxpayer decides to evade, we should have:

$$U_{jEV_1} > U_{j_1}^l$$

where U_{jEV_1} is the utility obtained from evasion by *j*, who is therefore a risk seeker. As we assumed that EV_1, as well as the taxpayer's attitude to risk, are constant, and remembering that $U_1^l > U_1^h$, it follows that at higher levels of income we should observe higher levels of evasion.

It is worth stressed that many experiments have found that at least some of the assumptions of expected utility theory may fail. The most interesting of these failures are, in my opinion, those reported by experiments A5 (Baldry, 1985) and A10 (Baldry, 1986). Since both these experiments are particularly interesting, in the following two files they have been described in some detail.

Experiment A5: *"Income Tax Evasion and Tax Schedule: some Experimental Results"*
Jonathan C. Baldry, 1985

Aim of the experiment
The experiment was designed to effects of net income and of marginal tax rates on tax evasion.

Methodology
Taking part in the experiment were two groups of volunteer students from the University of New England:

- **group A**, consisting of 20 first-year students of economics who received payment, plus 20 unpaid students used as a control group to establish whether payment was necessary to induce rational behaviour.
- **group B**, consisting of 20 third-year students of ecosystem management.

The experiment consisted of six rounds. At the beginning of each round the subjects received an envelope containing the following material:

- information on their amount of gross income for that round;
- instructions on how to calculate the amount of tax to pay;
- an income declaration form to be completed by each subject indicating the amount of income that s/he intended to declare and the corresponding taxes;
- a statement that some income declarations would be checked at random: for group A, 6 declarations out of 20 would be checked in each round; for group B, 5 declarations out of 20 would be checked in each round;
- the information that at the end of the experiment each subject would receive a payment corresponding to the amount of gross income received minus taxes and the fines paid.

The gross income for each group was defined randomly by a given distribution:

- used for group A was a Paretian distribution modified with a maximum of 200 and a minimum of 32. The average gross income was 60.
- used for group B was a rectangular distribution with a maximum of 300 and a minimum of 30. The average gross income was 88.

The tax rates were of 3 types for group A and only one type for group B.

Results and conclusions

The participation rate was the same for both groups. Tax evasion behaviour (the average increase in the taxes evaded and the average propensity to evade) was very similar in both of them as well. Yet these apparent similarities of behaviour between the two groups concealed a number of important differences:

- tax evasion behaviour was much more variable in group B. This is explained by the fact that the declarations in this group were made in public, while in group A they were compiled in private.
- whereas in group A only 31% of tax declarations were completed honestly, in group B the honestly completed declarations amounted to 54%. Following the Author the only explanation for this difference lies in the different types of language used on the forms: the information on tax rates and on fiscal controls used in group B was expressed in more forceful and formal language.

The theory of expected utility predicts that, when the control variables (probability of being checked and punishment) remain constant, tax evasion behaviour can only be explained by income. More specifically, it states that tax evasion is positively influenced by income; a contention largely borne out by the experimental results from group B.

Again according to expected utility theory, tax rates have no influence of tax evasion, and all subjects will attempt to evade taxes at least once. This prediction was not confirmed by the experiment: indeed, its results show that high tax rates encourage evasion.

Experiment A10: "*Tax evasion is not a gamble: a report on two experiments*"
J. C. Baldry, 1986

Aim of the experiment (experiment 1)

In the work described in the previous file Baldry conducted an experiment designed to test certain predictions of the 'standard' model of tax evasion, which views this activity as a simple game. Under a number of hypotheses concerning enforcement parameters (given) and the net income earned by individuals (exogenous), it can be shown that a risk-averse taxpayer, with a utility function defined on disposable income: (a) will always attempt to evade to the extent that the expected gain is positive; (b) will seek to evade more, the higher the level of his/her net income; (c) will always evade less with an increase in the probability of detection or in the fine; (d) the parameters of the tax function - the tax schedule - (marginal or average rate) by itself does not influence tax-compliance decisions. The experiment was designed to verify hypotheses (a), (b) and (c).

Methodology (exp. 1)

The subjects were allocated a gross income extracted from a given distribution in each of the 6 rounds of the experiment. They were given a tax schedule with which to calculate their taxable incomes and asked to complete an income-tax return. They were then told the probability of being audited and informed about the fines that they would have to pay if evasion was detected. The aim, therefore, was to replicate the tax imposition and control procedure(for greater detail see Baldry 1985) normally implemented by the tax authorities.

Results and conclusions (exp. 1)

The results consistently supported prediction (b) but rejected (a) and (d).

Firstly, it seems that the decision whether or not to evade is also influenced by "constraints, moral remorse"; it certainly does not depend on the net expected return on evasion alone.

Secondly, introduction of the marginal or average tax rate as an additional explanatory variable significantly improves the performance of the estimated tax evasion function, with a limited effect on the (significant) estimates already obtained for the other coefficients.

This suggests that, although the standard model provides a good basis for analysis of tax evasion, it should be improved: for example by including "moral costs" and the average or marginal rates as separate arguments in the utility function.

Aim and methodology (exp. 2)

In order to add further information to the above results, in October 1985 another experiment was designed and conducted. This experiment was formally equivalent to the previous one but it was presented as a gamble. The only difference was that, whereas in experiment 1 the probability of being audited was set at 0.25 and the fine at 2, with a net expected gain (NEG) of $0.25 per $ evaded in all rounds, in experiment 2 variable values of the fine and of the audit probability were used, enabling NEG to vary between -0.4 and +0.2 (negative in 2 rounds).

Given the structure of experiment 2 and the results obtained from experiment 1, the second set of results were expected to show the absence of 'moral costs' in gambling, so that the sum wagered (attempted evasion) would always be positive, unlike in experiment 1. Secondly, it was hoped to provide support for the hypothesis that the marginal or average tax rate has a distinct influence on evasion behaviour. This should have been evidenced by the greater amount of variance in actual evasion (AE) explained by net income, the probability of being audited and fined in experiment 2, compared with the amount explained only by net income in experiment 1. The residual variance of AE in experiment 1 would thus be due to the independent influence exerted by some fiscal parameter, whereas this influence would be absent in experiment 2 because the participants were not given a tax schedule for the income allocated to them, nor could they infer it.

Results and conclusions (exp. 2)

The fact that all the subjects always staked a positive sum in each round (implicitly, they attempted to evade), even in the presence of negative NEG, apparently supports the hypothesis that there are 'moral costs' involved in evasion which do not arise in the case of straightforward gambling.

Unfortunately, the data were of no great help in verifying the second hypothesis concerning a distinct influence exerted by fiscal parameters on tax-compliance decisions. The subjects always evaded the maxim amount available to them (i.e. all the tax due) in all rounds (flat regression equation).

The overall conclusion to be drawn from these experiments is that the traditional theoretical approach to tax evasion should be altered or supplemented, since evasion is a complex phenomenon, one not comparable to a simple gamble.

The main lessons to be drawn from A5 are two: the first is that when tax declarations are kept private, evasion increases, while it decreases when tax declarations are public. The second is that increasing tax rates also increases evasion. The important discovery made by A10 is that the subjects' behaviours changes if they are asked to take decisions in a context which resembles a gambling game or a real world situation.

The psychological pressure exerted by a public declaration and real world contextualisation seem to produce a similar discouraging effect on tax evasion. On the other hand, increased tax pressure produces a sort of defiance, which leads to an increase in tax evasion. The experimental subjects therefore seem sensitive to cultural values which act as a deterrent against tax evasion, but at the same time they react by evading more when they judge the tax pressure to be excessive. It should be pointed out that these considerations are not verified by Becker's experiments. They may therefore provide the basis for further experimental tests - like those, in fact, which I have conducted and report in the following chapters. More specifically, my experiments considered both the effect of public audits and the effects of an experimental design which models a real world context versus the effects produced by a pure game context.

Similar problems are investigated by two other experiments (or groups of experiments) worth commenting on. I refer to A11 (Webley, Halstead, 1986) and A12 (Webley, Morris, Amstutz,). Experiment A11 was divided into three separate experiments, all designed to investigate the relevance of the experimental context. I shall restrict my comments to the second and third of these experiments, given that the first one was "introductory", serving to provide some sort of reference frame for the ones that followed. By contrast, the second experiment conducts detailed exploration of the subjects' psychological attitude towards the experimental situation. More precisely, Webley and Halstead's second experiment sought to investigate, given certain instructions, how the way in which individuals perceive the experimental situation influences their tax evasion behaviour, taking account of the fact that, in general, a tax simulation can be interpreted in at least four different ways: (i) as an optimisation problem, (ii) as a game, (iii) as a simulation of income declarations, (iv) as a psychological experiment.

The main results of this experiment are the following:

- 10 subjects (the total number was 16) saw the situation as a game. They also stated that the fact that the simulation was carried out on a computer may take them to associate it closely with a video game. These subjects tended to declare only part of their income.
- 3 subjects perceived the context as a mathematical optimisation problem and tended to adopt an 'all or nothing' approach to tax compliance.

- 3 subjects believed that the situation was one of actual income-tax declaration. They were almost all honest 'taxpayers' who justified their behaviour by saying that 'it is wrong to evade' and that 'it would be too shameful to be caught' (honesty component).

Despite the fact that the majority of the subjects viewed the situation as a game, and that their strategies changed according to their perception of it, it was not possible to conduct qualitative analysis of these data because of the small size of the group of subjects and the uncertain nature of the classification outlined above. A different approach was therefore required to demonstrate the existence of a link between the subjects' perceptions of the experimental situation and quantitative measures of their behaviour. This issue was addressed by study 3, which varied the instructions given to the subjects. The results obtained from this third experiment provided quantitative confirmation that the various perceptions of the experimental situation, already discovered in the second experiment, may have diverse consequences on the decision-making strategies adopted by individuals - strategies also conditioned by the fact that the subjects knew that they were involved in an experiment, not in a real-world situation. It was shown in particular that variations in the instructions given to the subjects, and able to alter their individual perceptions of the experimental context, may give rise to very different types of fiscal behaviour, even in the presence of equal fiscal and enforcement parameters (as I have already pointed out when analysing the results from Baldry 1986).

Another experiment closely related to my own experiments described in the following chapters is experiment A8 (Alm, Jackson, McKee, 1992), which reports the effects exerted by the introduction of a public good. This factor has a negative effect on evasion: that is, the introduction of a public good, produced by using the tax revenue, seemingly reduced evasion.

Finally a more general but no less important lesson to be drawn the whole A group of experiments regards methodology. Inspection of the experimental designs reveals the following common features:

1) the number of experimental subjects is always quite small (ranging from a minimum of 13 persons – experiment A3 by N. Friedland – to a maximum of 56 – experiment

A4 by Chang, Nichols and Schultz – although this maximum is exceeded by almost all the experiments in groups B, C and D);

2) the experimental subjects were all students;
3) most of the experiments were carried out without the aid of computers, using envelopes, questionnaires, etc., instead. Experiments A11 (Webley, Halstead, 1986) and A12 (Webley, Morris, Amstutz, 1985) are the exceptions to this rule;
4) many experiments provided the subjects with clear information on how to compute their taxes, fines in case of evasion, etc.

2.4.2 Group B, tax equity and group C, explanations given by subjects

The experiments belonging to group B and C share the common feature that they investigated topics on the border between economics and psychology. The main factors investigated by these experiments were the following:

1) unfairness of the tax system (exp. B1, B3)
2) social or personal justifications (exp. B2, C1, C2).

The other experiments in these groups, i.e. B4 and C3, respectively analysed taxpayer behaviour in an international context (B4), and the effects of some specific methods of tax evasion deterrence.

The main findings of the experiments analysing the role played by the perceived unfairness of the tax system are the following:

a) the degree of unfairness of a given tax system is subjectively measured on a comparative basis, i.e. the subjects evaluate their position as taxpayers by looking at the other participants in the experiment and then deciding whether or not they have been correctly taxed;
b) the perception of tax fairness derives mainly from assessment of the value of tax pressure, while the other components of the fiscal system are less influential on subjects' beliefs.

In my opinion, the most interesting of the experiments on fiscal fairness is experiment B1 by Spicer and Becker (1980), which I briefly summarise in the following file.

Expriment B1: *"Fiscal inequity and tax evasion: an experimental approach"*
Michael W. Spicer and Lee A. Becker, 1980

Aim of the experiment

The purpose of the experiment was to examine the relationship between the perception of inequity in the tax system and tax evasion. The aim was to verify the following proposition: "the amount of taxes evaded increases among victims of inequity and decreases among its beneficiaries", the intention being to clarify whether the perception of inequity effectively increases evasion or whether it is instead only one way to rationalise illegal behaviour.

Methodology

The game consisted of a tax game lasting ten 'monthly' periods in which the subjects were confronted by hypothetical decisions on tax evasion. Participating in the experiment were 57 students from the University of Colorado, 21 males and 36 females, aged between 21 and 29.

At the beginning of the game the participants were told that:

- each player would receive the same wage at the beginning of every month;
- each of them had to decide how much of his/her wage to declare and then pay the relative tax;
- in each period, randomly selected participants would be audited and if the tax paid was less than the sum due, fines equal to 15 times the amount of tax evaded would be inflicted. The participants were informed that there was 1 chance in 15 of being checked, and that checks were made only on taxes evaded in that month.

The objective of each participant was to maximize his/her net income (gross income - taxes paid - fines), on which basis a money reward was distributed at the end of the game.

The subjects were also given further, false, information on tax rates in order to induce some of them to feel that they were being treated unfairly. All the subjects were informed that the tax rate was 40%. But then 19 of them were told that the average rate was 65%, while a further 19 were told that the rate was 15%. The remaining 19 subjects were told the truth, i.e. that all participants paid at the same rate.

When the ten months had passed, a questionnaire was administered to the subjects in order to ascertain their perception of, and attitude towards, tax evasion.

Results and conclusions

The results indicate that on average the participants in the experiment evaded 23.13% of the taxes payable, and that the percentage of evasion was higher among those who had been told that they had to pay at a higher-than-average rate, and lower among those informed that they would be paying at a lower-than-average rate.

Moreover, the results of the regression show that with respect to the dependent variable 'percentage of taxes evaded':

- the coefficient relative to the tax rates was positive and significant;
- sex had a significant influence on evasion: other variables remaining equal, males evaded more than females;
- age and earnings did not seem to be significantly correlated with evasion.

These results therefore supported the proposition that a perception of unfair treatment increases tax evasion.

The main point of interest concerning Spicer and Becker's experiment is the very clean information that it provides about the relationship between tax fairness and evasion. The Authors underline that the relationship between tax pressure and evasion follows a linear increasing path. The existence of this relationship can be of crucial importance for the correct design of new experiments, and it must be carefully considered when analysing the data from experiments on tax evasion.

Clearcut conclusions are less easy to draw from the results of experiments analysing the impact of different socio-economic scenarios than they are from the results of experiments on tax fairness. In particular, it is rather difficult to specify the effects produced by a situation of individual need as a justification for tax evasion. Some experiments indicate that this individual condition may or may not be seen by subjects as a valid reason for evasion. The results are strongly influenced by other conditions introduced in the experiment, like for example the social attitude towards tax evasion. Furthermore, the designs of these experiments are often so different that direct comparison between the results is even more problematic than the usual.

Nevertheless, some lessons can be drawn even from these experiments, viz.:

a) the decision to evade is not based on a merely economic calculation of the expected monetary reward from evasion but is closely influenced by socio-economic factors;
b) an individual's reputation can indirectly influence the behaviour of the other taxpayers, i.e. if it is known that a taxpayer with an high moral reputation has evaded, the propensity to evade of the other subjects increases;

c) the explanations given by the subjects for their decision to evade are related more to external factors (i.e. social or cultural elements) than to internal causes (i.e. individual socio-economic characteristics).

Finally, it should be noted that the experiments in these groups all adopted some sort of mixed methodology whereby experiments were combined with questionnaires. When interpreting the results, therefore, particular care should be taken not to mix considerations relative to the opinions expressed by the subjects with ones relative to their actions during the experiments. Actions and opinions lie at different cognitive levels and must be carefully confronted in order to avert the risk of considering them part of the same decision process. From a methodological point of view, the main considerations concerning the experiments in groups B and C are the following:

1) sex may have a significant influence on evasion;
2) many experiments avoided the use of students as experimental subjects (experiment B3 by Hite, experiment B4 by Robben, Webley and Weigel, experiment C2 by Hite, experiment C3 by Thurman);
3) many experiments used subjects of very different ages.

Some experiments (e.g. experiment B4) mixed and compared results from very heterogeneous samples (comprising students or ordinary people or specially selected subjects – high-income earners). These comparisons seem to demonstrate that a particular bias is introduced by a specific category of subjects.

2.4.3 Group D: imitation among evaders

This final group comprises only two experiments, both of which sought to analyse the mental process followed by experimental subjects when they had to decide on paying taxes. More precisely, these experiments concentrated on imitation - that is, on whether the subjects look at the behaviour of the other participants in the experiment when taking their decisions. Specifically, experiment D2 analysed the imitative behaviour in the context of attribution theory, while experiment D1 was simply concerned with the effects of imitation *tout court*.

The results seem to suggest that imitation does not greatly influence the decision to evade, while experience and the building a system of individual rules are apparently more important. The file for experiment D2 by Kaplan, Reckers and Roark (1988) follows. In my opinion, it is the most complete.

Experiment D2: *"An Attribution Theory And Analysis of Tax Evasion related Judgements"*
Steven E. Kaplan, Philip M. J. Reckers and Stephen J. Roark, 1988

Aim of the experiment

The experiment examined the connection between the causal attributions made by subjects regarding tax evasion by others and their own intention to evade taxes. The aim of the experiment was to identify the circumstances in which taxpayers justify evasion and which may therefore encourage their own tax evasion.

Methodology

The theoretical approach used in this experiment differed from that usually adopted in fiscal research. Instead of concentrating on real tax evasion, brief scenarios of hypothetical cases of evasion were used. The experiment consisted of two studies (A and B) which applied attribution theory to the phenomenon of tax evasion.

The same procedure was used in each experiment: 99 subjects took part in study A, and 105 in study B. Each subject was presented with a single scenario containing two manipulated subjected variables, viz.:

Study A

taxpayer need

a) high need condition: a taxpayer was described as extremely needy because of recent major family medical expenses;

b) low need condition: in this case too, the taxpayer was described as having faced major medical expenses but that they had been paid by an insurance policy or out of savings.

taxpayer consensus

a) high social consensus condition: the taxpayer was told that tax evasion was very common and was becoming even more serious;

b) low social consensus condition: the taxpayer was told that a very small percentage of people evade taxes.

Study B

Salience

a) high salience condition: this scenario states that a taxpayer is generally an 'honest businessman';

b) low salience condition: this scenario states that a taxpayer is generally 'a shrewd businessman'.

Social need:

a) high social need condition: this scenario states that tax evasion seriously affects the fairness of income tax and makes higher tax rates necessary in order to recoup lost revenues;

b) low social need condition: this scenario states that tax evasion has little effect on national income and that it therefore does not make any increase in income tax rates necessary.

The task of each subject was to respond to the following two dependent variables:

1. *causal attributions*: the subjects were asked to assess to what extent tax evasion is influenced by the character of the taxpayer and to what extent by situational/environmental factors;

2. *intention*: the subjects were asked if, in the same circumstances as described in the scenario, they would adopt the same evasive behaviour.

At the end of the experiment, the participants completed a questionnaire asking them for information about:

- age;
- which of the five tax brackets they belonged to;
- if tax evasion is immoral;

Results and conclusions

Causal attributions

Study a: ancova 2x2 analysis, in which the independent variables were taxpayer consensus and need, while age and income bracket were co-varied, showed that both the manipulated factors (consensus and need) were significant in explaining the causal attributions. In fact, when the taxpayer's need was high, external attribution to the environment was 39%, whereas when consensus was low external attribution rose to 52%. These results were not as predicted by the first hypothesis of attribution theory (see Section 2).

Study b: ancova 2x2 analysis, in which the independent variables were salience and social need, while age and income bracket were co-varied, showed that only salience was a factor significant in explaining the causal attributions. In fact when there was a high salience condition, the external attribution was 46%, while when it was low external attribution was only 37%. Thus the second hypothesis made by attribution theory is supported. Information on social need is not significant. Consequently hypothesis 4 of attribution theory is not upheld.

Intentions

The following results were obtained from regression analysis of the overall data from studies A and B, in which the independent variables were causal attributions and moral beliefs:

1. the intention to evade was high among subjects with high external causal attributions;

2. subjects who considered tax evasion not to be immoral stated that they had a high intention to evade.

These findings seemed to support hypotheses 5 and 6 of attribution theory.

The methodological problems implied by experiment D2 are in my opinion more serious than those confronted by the other experiments discussed. I believe, in particular, that the results reported by experiment D2 were closely influenced by the specific way in which either the so-called "salience" and "social need" factors were modelled. Applied psychologists have demonstrated (e.g. Kahneman, Slovic, Tversky, 1982) that even small changes to the lexicographic description of an experiment can produce great differences in results. Consequently, a simple change to the language (the syntax) used to describe the scenarios which Kaplan, Reckers and Roark used to check the influence of the factors analysed by their experiment may give rise to different results.

2.5 Some brief methodological considerations

Returning to the theoretical discussion of previous sections, and looking at the topics investigated by the experiments hitherto described, the main conclusion to be drawn is that expected utility theory is still the most powerful theoretical framework with which to start. One reaches this conclusion, not because the expected utility maximisation theory always fits the results of experiments, but because almost all the influencing (or supposedly so) factors can be included in a micro-economic model and rigorously tested. By contrast, neither prospect theory nor so-called attribution theory is able to offer this opportunity because they lack an equally powerful analytical apparatus. This limitation is particularly evident as regards attribution theory, although prospect theory is to some extent able to overcome it. The analytical problem with prospect theory is that it is difficult to build a formal model of the first stage of the decision-making process, that is, the so-called 'editing step'. This first stage is of crucial importance because it determines the reference point for the decision-maker and therefore splits the value function. After the reference point has been determined in the editing stage, the decision-maker's behaviour is described by prospect theory in a manner that does not differ greatly from that of the traditional expected utility approach.

It is also worth emphasising that the expected utility model is the only approach to tax evasion that forms part of a more general theoretical framework. Starting from an expected utility model, one can insert the tax-payer decisional problem into neo-classical economic theory, connecting it with the theoretical architecture of the entire economic system. This means that, if necessary, it is possible to build organic connections with other economic problems. An example of this way of connecting tax evasion with other economic spheres of decision is provided by the relatively recent literature on tax evasion and monopoly (Kreutzer and Lee, 1986; Wang and Conant, 1988; Wang, 1990; Lee 1997). The central issue analysed by this literature is the relationship between the decision to evade profit taxes and the profit maximising output level of the monopolist. Even though the aims pursued by this body of literature are only theoretical, there are some findings from the experiments on tax evasion (those designed on the basis of the expected utility model) that can be related to the theoretical results obtained. The best example of this potential link is the effects produced by different audit-punishment systems (high fines versus high probability of being detected) on the experimental subjects.

The experimental literature on tax evasion has shown that subjects react differently to an increase in the fines level or to an increase in the audit probability. On the other hand, the above mentioned models of the monopolist who must cope with the joint decision to evade and to fix her/his optimal output level do not distinguish between the effects exerted by an increase in fines or in the audit probability. As both the literature on tax evasion and monopoly and the experiments that study the role played by fines and audit probability start from a common theoretical frame, more or less directly inspired by the Allingham and Sandmo model, it follows that the experimental findings can be easily transferred to the theoretical debate on profit taxes and monopoly.

Similarly, even though the experiments reported in this thesis analyse income tax evasion, points of contact can be found with the parallel theme of profit taxes evasion, or with other topics related to the economic effects produced by taxes, because the theoretical frame used by my experiments is coherent with the microeconomic theory.

A second consideration arising from the discussion of the experimental literature on tax evasion is that a very large number of designs have been tested and accepted. This means that the planners of a new experiment benefit from quite ample freedom in deciding its operational aspects. For example, there are no restrictions on the choice between carrying out the experiment using material support (envelopes, questionnaires, real money, etc.) or computers which simulate the experimental environment.

On the other hand there are some methodological considerations that should be borne in mind, most notably:

1) Since sex seems to be of some influence, it is better to keep the experimental subject samples gender-balanced (with 50% males and females, if possible).
2) The number of experimental subjects does not seem to be particularly important, but it is preferable to have at least 25-30 subjects for each experiment.
3) The experimental context is crucial and must therefore be kept under control, especially if the experiment is to be repeated several times.
4) The large number of factors that may affect the decision to evade taxes suggests that simple experiments should be conducted with only a few variables involved.

I shall return to these methodological issues in a later section devoted to the practical problems that must be solved when setting up an experimental laboratory.

3. The theoretical model and the experimental schemes

Foreword

The following introduction and sections 3.2 and 3.3 of this chapter formed the basis of sections II and III of Bosco and Mittone (1997 p. 298-302), and they were discussed and written jointly by Bosco and myself. Section 3.3 and sections 4.1, 4.2 and 4.3 of the following chapter are an extension of sections IV, V, VI and VII of Bosco and Mittone (p. 303-321) and they have been written by myself alone.

3.1 Introduction

The survey of the theoretical literature in the previous chapter showed that, from a microeconomic perspective, tax evasion has been mainly studied as a problem of choice under uncertainty (Allingham and Sandmo, 1972): like any portfolio manager, the taxpayer has to allocate her/his fixed gross income between two assets: a risky asset which is tax evasion, and a safe asset (with a zero return) which is tax payment. Tax evasion activity is risky because there is a certain probability that it will be discovered and punished. As suggested by the portfolio theory, the taxpayer's choice will be affected by her/his preferences - mainly by her/his attitude towards risk-taking - and by the return on the risky asset determined by the tax structure, which includes both the tax rate and the penalties in the case of evasion.

However, the pure gamble model appears unsatisfactory on various grounds. Among these, and most importantly for my present purposes, it neglects the psychological aspects of the decision to evade tax because it rules out any feeling of shame about evading or being detected and punished, and it ignores any intrinsic pleasure derived from successful evasion. In other words, the pure gamble model does not take full account of the moral constraints involved in the tax evasion decision.

This theoretical perspective is not completely new and has been explored by at least two articles: Gordon (1989) and Myles and Naylor (1996). Both these works take the hint from the problem of justifying the failure of the standard Allingham and Sadmo's model in predicting the effects produced on evasion by an increase in tax rates (as reported by some empirical studies e.g. Clotfelter, 1983). The standard model predicts that if the tax rates increase then tax evasion should reduce, while the empirical observations show the opposite. Gordon tries to justify this failure of the Allingham and Sadmo's model by suggesting that the decision to evade taxes generates a "psychic cost" and that this cost increases as the amount of taxes evaded rises. The model by Gordon goes in the direction here followed but has been criticised by Myles and Naylor exactly because of this assumption of direct relationship between psychic costs and tax evaded. Following these Authors there are no reasons to justify this hypothesis and they suggest a different solution to the problem. The Myles and Taylor's model links in fact the decision to evade to a sort of "reputational" budget. The tax payer evaluate the possibility to evade by attributing a value to her/his social reputation that could suffer a damage if s/he will be detected as evader. The final aim of the Authors is to reconcile the standard model with the empirical observations.

The main difference between the Myles and Taylor's model and the theoretical approach here adopted is that I include in the utility function of the tax payer not only psychological costs related to a some sort of value given by society to honesty, but also a moral cost that derives from a strictly individual value system. This cost has been called "Kantian" and will be described in the following section.

3.2 The tax payer model as a *pure gambler* model

Adopting a partially different version of the model illustrated in the introduction I shall assume that the taxpayer has a Von Neumann-Morgenstern utility function that is concave in consumption:

$$E(U) = (1-\pi)\, U\{Cs\} + \pi\, U\{Ca\}$$

where:

λ is the percentage of tax evaded ($\lambda=0$ if the taxpayer is perfectly honest, $\lambda=1$ if the taxpayer is perfectly dishonest);

Y= income;

π is the probability that evasion will be discovered;

t is the tax rate;

$Cs = [1-t(1-\lambda)] Y$ is the consumption level enjoyed if the taxpayer escapes detection;

$Ca = [1-t -\lambda P(\lambda)t] Y$ is the consumption level should the taxpayer be caught and punished;

$P(\lambda)$ is the punishment mechanism which links the surcharge to the level of evasion.[3]

Under these assumptions the taxpayer's problem is as follows:

$$\max_{\lambda} E(U)$$

From the first order condition of this problem we can obtain the optimal level of evasion:[4]

$$\lambda^* = \frac{(1-\pi)U'\{Cs\} - \pi P(\lambda)U'\{Ca\}}{\pi P'(\lambda)U'\{Ca\}}$$

The traditional analysis seemingly assumes that everyone except the tax administration behaves as an isolated individual, playing a *game against nature.* However, the cognitive process leading up to the decision to evade tax appears to be a more complex and richer process, in analysis of which the individualistic approach is clearly unsatisfactory. Among other things, it overlooks the possibility that the tax evasion decision may be driven by perceived injustices or inequalities in the tax system, and it neglects the influence of the prevailing *social climate* on the decision of the taxpayer to violate the fiscal law.

We have seen from the review of the empirical literature that numerous components of the theory can be either criticised or enriched by considering the role played by socio-economic and psychological factors. More precisely, the results of most empirical studies point to the general conclusion that the tax evasion game cannot be reduced to a

[3] I assume that the penalty rate is imposed on evaded tax, an institutional device used in many developed countries. I further assume that $P'(\lambda) > 0$ and $P''(\lambda) \geq 0$.

[4] The first order condition problem is:

$$\frac{\delta E(U)}{\delta \lambda} = (1-\pi)U'\{Cs\}tY - \pi U'\{Ca\}\left[P(\lambda) + P'(\lambda)\lambda\right]tY = 0$$

The second order condition is verified once it is assumed that $U''\{C\} \leq 0$. This rules out the case of a risk-loving taxpayer , i.e. a taxpayer willing to accept an unfair gamble.

pure gamble. On the contrary, rather than being solely a pure gambler, a taxpayer is also a free rider: by evading tax s/he is not excluded from consumption of the public goods. The taxpayer may therefore be aware that her/his evasion will damage the welfare of the community in which s/he lives: hence evasion may produce different types of psychological cost. On the other hand, it cannot be ruled out that, in the same circumstances, and mainly when the taxpayer is convinced that s/he is paying *too much* in absolute or relative terms or with respect to the public goods provided, an increase in welfare, as well as the saved tax payment, may accrue to the taxpayer when evasion is successful.

It should also be noted that the model proposed here includes only the consumption of a private good, while any utility is obtained from consumption of the public goods produced by the tax revenue. The consumption of a public good has been excluded because the individual contribution to total tax revenue is not relevant, and therefore the amount of public good can be assumed as a constant.

3.3 The rational tax payer with moral constraints

In this section I shall extend the model set out in section 2.1 so that full account can be taken of the moral constraints involved in the tax evasion decision. The first problem is therefore formulating a definition of the concept of moral constraint in the tax evasion context. This topic has been partially treated by the literature and from various perspectives, of which two are of particular interest here:

1) *the "Kantian" morality approach* (Laffont, 1975; Sudgen, 1984): this approach is broadly related to Kant's definition of morality and is based on the assumption that, for a given taxpayer, a "fair tax" ($\bar{t}Y$) is the amount of money that s/he believes fair for all other taxpayers to pay under the same conditions.[5] Assuming that the tax-payer deems the tax imposed by the Government to be fair, then the decision to evade becomes to

[5] The degree of the perceived (un)fairness of the tax burden depends mainly on the amount of services (public goods plus merit goods) that the state provides. Wealth redistribution may be seen as one of the duties performed by the state and can therefore be included among the services that it provides. In this sense the degree of perceived tax fairness should also depend on the degree of inequality, and on the expected effectiveness of the equity policies implemented by the state.

some extent constrained by the knowledge that her/his evasion will reduce the amount of resources available for social welfare.

Thus a Kantian moral cost $K(\lambda)$[6] can be defined where $K(\lambda)$ represents a psychological cost incurred irrespective of whether the act of evasion is observed. The effectiveness of this deterrent rests on the assumption that a false declaration will generate anxiety, guilt or a reduction in self-image. It should be stressed that my hypothesis is that taxpayers feel these costs only if they do not believe that they are not paying more taxes than is fair. It is fairly obvious that no moral constraint can work as a spontaneous device to reduce tax evasion if taxpayers feel that they are subject to an unfair tax burden. If this is the case, and then $t > \bar{t}$, rather than inducing guilt or a reduction in self-image, tax evasion may be perceived as necessary self-defence, and the act of tax evasion in itself may increase the taxpayer's welfare.

2) *the social approach*: under this approach the taxpayer is not exclusively interested in her/his own welfare but is also concerned about the general opinion in her/his society towards tax evasion. It may thus be defined as a moral constraint $S(\lambda)$ based on the social evaluation of tax evasion which can be represented as a non-pecuniary cost caused by the damage to the evaders' reputation resulting from detection.[7]

It therefore represents what I shall call the *social stigma*: the moral cost incurred by an individual who is discovered to be in breach of the law.[8] In other words, we may imagine that tax evasion is subject to moral censure in a given society. In this case, those who decide to evade must consider the risk of being both fined and censured by public opinion, even when they do not feel any moral constraint to evade. The intensity of this social stigma clearly depends on the extent to which evasion behaviour is widespread in the community. The social stigma may be very great if the taxpayer perceives him/herself to be in the tiny minority, but if there is a economy-wide propensity to tax evasion, s/he may feel far less morally culpable. Note that what is important is the prevailing *perceived* rate of evaders, because the true number of evaders is unknown not only to tax payers but to the fiscal Authority as well. Our assumption is

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[6] I assume that the cost component K is an increasing function of λ.

[7] I assume that the cost component S is an increasing function of λ.

[8] I may also appeal to the literature on social customs (Akerlof, 1980 and Naylor, 1989). See also Gordon, 1989

Under these assumptions, the utility function of the taxpayer becomes:

$E(U) = (1\text{-}\pi)\ U\{Cs,Ms\} + \pi\ U\{Ca,Ma\}$

where:

$Ms = (\bar{t} - t)K(\lambda)$ and $Ma = (\bar{t} - t)K(\lambda) + (\bar{\mu} - \mu^e)S(\lambda)$

In order to render the problem analytically tractable, I assume that $U_{CM}=U_{MC}=0$, $U_{MM}=0$ and $K''(\lambda) = S''(\lambda)=0$. The taxpayer's problem is still the following:

$\underset{\lambda}{\text{Max}}\, E(U)$

but under these assumptions, the taxpayer 's utility function is:

$E(U) = (1\text{-}\pi)\ U\{Cs\} + \pi\ [U\{Ca\} - (\bar{\mu} - \mu^e)S\lambda] - (\bar{t} - t)K\lambda$

From the first order condition we can obtain the optimal level of evasion λ^*:

$$\lambda^* = \frac{(1-\pi)U'\{Cs\} - \pi P(\lambda)U'\{Ca\}}{\pi P'(\lambda)U'\{Ca\}} - \frac{\pi(\bar{\mu} - \mu^e)S + (\bar{t} - t)K}{\pi P'(\lambda)U'\{Ca\}tY} \qquad [3.1]$$

The optimal level of evasion depends on two terms: the first displays the role played by both the structure of the gamble - that is, the probability of being audited and the punishment function - and the taxpayer's risk propensity - that is, the curvature of her/his utility function. This first part of equation [3.1] shows results quite similar to those obtained by the traditional approach to fiscal evasion (e.g. Srinivasan, 1973). The second term of [3.1] displays the role played by the moral factors. It suggests that optimal evasion will decrease with an increase in social stigma (*S*), unless the evasion level perceived as physiological by the tax payer (μ) is lower than the perceived average level of evasion in society (μ^e). Similarly, the optimal evasion will decrease with an increase in the Kantian moral cost (K): in this case too, the direction of the effect of K on λ^* depends on the difference between the perceived fair tax ($\bar{t}$) and the current tax level (t).

It is now evident that the fairness of the gamble, even when accounting for the degree of risk aversion, is not longer sufficient to generate evasion behaviour. In order to induce evasion the fairness of the gamble must overcompensate the psychological costs involved in the tax evasion decision. This finding explains some experimental results (for example Baldry 1985, 1986) which show that there are some people who choose not to evade even if it is apparently convenient for them to do so. On the basis of the apparatus used here, we may state that the non-pecuniary disadvantages for these taxpayers were higher than the pecuniary advantages deriving from evasion. It is worth noting, moreover, that the moral constraints were defined in such a way that the opposite result is possible as well.[11]

Whatever the sign of the parameters, one notes that in the model proposed here the level of evasion depends not only on the tax-enforcement variable (t and P) and on the probability of being audited (π) but also on variables which, albeit naively, capture the role played by the prevailing *social climate* and by perceived injustices or inequalities in the tax system.

It is of interest to investigate the sign of the comparative static analysis, since this will reveal whether my model is able to shed light on the discrepancies between the comparative static results obtained by theoretical analysis and those deriving from experimental and empirical inquiry. In the case of an increase in the tax rate, the result on the optimal level of evasion is no longer definite:

$$\left.\frac{\delta\lambda^*}{\delta t}\right|_{M\neq 0} = \left.\frac{\delta\lambda^*}{\delta t}\right|_{M=0} + \frac{K}{-SOC}$$

In this case, the effect of an increase in the tax rate can be distinguished into two different and opposite effects: a wealth effect of negative sign, as long as the assumption

[11]The effect of moral constraints on the decision to evade is, in fact, contingent on the sign of $(\bar{\mu} - \mu^e)$ and $(\bar{t} - t)$. If the level of taxation is perceived as too high, and as therefore unacceptable to the taxpayer - $(\bar{t} - t) < 0$, and/or if the proportion of evaders in the community is judged to be greater than

of DARA is retained, and a *tax unfairness* effect that is positive. The overall effect is not unambiguously definite *a priori*. However, it may happen that if the value of K is sufficiently high - i.e. if the tax unfairness effect is relatively stronger than the wealth effect - the result obtained by the traditional analysis is reversed, so that the level of evasion tends to increase with an increase in the tax rate. The reason for this is quite obvious: an increase in tax either decreases the psychological cost of evasion (if $(\bar{t}-t)>0$) or increases the pleasure of evasion (if $(\bar{t}-t)<0$).

Interestingly, if $\bar{t}$ decreases, the level of optimal evasion increases.[12] When, owing to political or cultural changes, the level of tax judged to be *fair* by taxpayers decreases, the incentive to evade increases, as well as the optimal level of evasion.

Although I have not defined the cognitive process determining the perceived average level of evasion, it is reasonable to assume that this variable is in some way directly influenced by the true (albeit unknown) level of evasion.[13] In this sense, the evasion choice can no longer be considered to be merely individualistic. Assuming that μ^e is directly influenced by the actual total number of evaders, the behaviour of the other taxpayers will enter the optimal response function of our taxpayer.

We observe that:

$$\frac{\delta\lambda^*}{\delta\bar{\mu}}=-\frac{\delta\lambda^*}{\mu^e}=-\frac{S}{-SOC}$$

Therefore, as just said, the optimal level of evasion depends negatively on the subjective judgement of the physiological, and therefore acceptable, average level of evasion, and positively on the perceived current proportion of evaders in the community. Note that this introduces a dragging effect: should a change occur in one of the variables affecting the decision to evade (tax rate, tax surcharge, income, probability of being audited), there will be a direct effect on the individual's decision to evade and an indirect effect based the change induced in $\bar{\mu}$. Furthermore, some of the factors

the normal, physiological, proportion - $(\bar{\mu}-\mu^e)<0$ - moral considerations may operate in reverse and increase the level of evasion.

[12] More precisely: $\frac{\delta\lambda^*}{\delta\bar{t}}=-\frac{K}{-SOC}$

influencing the perceived tax fairness may be completely independent of fiscal policy. For example: since wealth redistribution can be considered one of the duties performed by the state, the level of perceived tax fairness should depend directly on the degree of inequality in society, and on the perceived effectiveness of the equity policies implemented by the state.

3.4 Hypotheses to test: the experimental schemes

My discussion of the theoretical approaches to tax evasion and analysis of the theoretical model proposed here show that there may be more than one explanation for taxpayer behaviour. I have chosen to adopt a traditional utility optimisation theoretical framework because I believe that it is still the most effective of the possible theoretical approaches to the problem. Nevertheless, I have stressed that theoretical analysis alone leaves a number of issues unresolved. The experimental approach can help to resolve these questions while suggesting improvements to the theoretical analysis. The main advantage of experiments is that they allow clear distinctions to be drawn among the effects produced by different variables over a given (observed) phenomenon. More precisely, among the possible empirical approaches to the study of tax evasion, only experimentation allows direct observation of the existence and relevance of a relationship between subjective factors and behaviour.

There are two main alternative empirical approaches to the study of tax evasion: the first is analysis of statistical data (an example of this kind of analysis is given by the first chapter of this thesis), the second is the administering of questionnaires. The drawback to the first approach is that it does not allow investigation of the role played by psychological factors, like the ones suggested here, while the weakness of the questionnaire approach is that the data collected are based, not on observed behaviour, but on the opinions declared by the subjects investigated.

Obviously, neither is the experimental approach exempt from risks and limitations, as we shall see in the following pages, but the great number of alternative theoretical

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[13] Many factors influence the perceived rate of evaders, among them the prevailing attitude of the media towards the phenomenon, the relative position of each taxpayer with respect to the others (a poor taxpayer may have a different perception of evasion from a rich one), and so on.

scenarios developed on taxpayer behaviour open broad space for experiments aimed not, or not solely, at falsifying the theories but mainly at increasing direct knowledge of such behaviour. In the final chapter, I shall attempt to build a taxonomy of the behaviours observed and collected from the repeated experiments that I carried out in the Experimental Economic Laboratory of the University of Trento.

Summarising the foregoing discussion, the more interesting hypotheses to be experimentally tested are the following:

H_1) Does a feeling of social blame somehow influence the decision to evade taxes? My assumption is that the adoption by the fiscal Authorities of a device that publicise the identity of the tax evader, exposing her/him to the collective blame, should reduce the propensity to evade taxes.

H_2) Does knowledge that one is damaging others (or reducing the value of some sort of social welfare function) reduce tax evasion? I expect this moral cost[14] to reduce the number of tax evaders.

H_3) Is there any form of mutual reinforcement between the two forms of moral constraint, or are their effects independent? I assume that joint action by both constraints achieves the best results in terms of reduced tax evasion.

H_4) Does the perceived fairness of the tax system have any effect on taxpayer behaviour?

H_5) Is it true that the level of evasion at a given time has an effect on taxpayer choices?

The main problem is finding a way to test all these hypotheses. In particular, testing the role played by the moral constraints described in the theoretical model seems very difficult. As I have said, the choice of experimental testing appears almost obligatory: otherwise, it is almost impossible to collect hard statistics on the role played by these psychological components of the tax compliance decision.

Nonetheless, even in an artificial experiment it is anything but easy to produce an 'artificial' feeling of collective blame, and to test the effects of subjective moral constraints. In particular, it is very difficult to be sure that the artificial environment of the experiment reproduces some sort of moral value system really felt by participants.

[14] I shall use the term "moral cost" synonymously with "moral constraint", and *vice-versa*.

Furthermore, it is even harder to be sure that what I call 'subjective moral constraint' and 'collective disapproval' are perceived by the participants in the manner desired.

Owing to these difficulties, and because of the quite large number of hypotheses to be tested, I tackled the problem by carrying out several experiments. More precisely, I carried out two one-shot experiments, one performed in Trento (experiment ST1, where ST means "static") and the other in Milan at the Catholic University (experiment ST2), and five repeated choices experiments in Trento between 1995 and 1997 (experiments DY1, DY2, DY3, DY4 and DY5, where DY means "dynamic").

In order to increase the amount of information, I also decided to submit a list of questions to the participants in the one-shot experiments. These questionnaires - presented in detail in the Appendix - were designed to explore the participants' opinions on topics closely related to each experiment (e.g. the perceived audit risk, the moral importance attributed to tax evasion, etc.). Some of these questions were extracted from a field survey conducted by the Italian Exchequer, and they made it possible to test the degree of homogeneity between the participants' opinions on these problems and those of the Exchequer's sample.

It should be mentioned that I also used this field survey to weight the tax rates used in the ST1 and ST2 experiments. As we have just seen, in fact, one of the problems implied by the moral constraint is that if participants feel that they are unfairly taxed, they may be powerfully induced to evade. Although, as said, I did not investigate the extent of this phenomenon, some guarantee is needed that the disincentive effects of what I have called 'moral constraints' are not weakened too much by the incentive effect produced by a perceived unfair tax pressure. For this reason, the tax rates used here are similar to those considered "normal" by the majority of the respondents to the Exchequer's questionnaire.

3.5 How to carry out an experiment and set up an experimental laboratory

This thesis has been planned and written contemporaneously with the setting up of the Experimental Economics Laboratory at the Department of Economics of the University of Trento. Consequently, I was able to learn how to run an experiment while at the same time participating in the setting up of a laboratory as one of its members.

The experiments that I designed and performed at the laboratory confronted me with a wide range of decisions to be taken when carrying out economic experiments. The best way to describe these decisions is to relate them to the phases of an experiment. I have summarised the experimental steps and the operational actions necessary to carry out each stage in the scheme given in Table 3.1.

Table 3.1 highlights the complexity of the entire process of conducting an experiment. As the figure in Table 3.1 is a simplified scheme, it is useful to comment on each step of the central stages of the process, i.e. phase B and phase C, which represent the core of the operational aspects of the experiment. Phases A and D are not really operative stages and have been added to the scheme simply to complete the picture of the whole process.

The operational start of an experiment is its project (design). This is a crucial moment because errors committed in this phase may compromise the quality of the data collected, potentially vitiating the results of the whole experiment. Furthermore, a good experimental design reduces the risk of making mistakes in the subsequent phases of the experiment itself. The design phase is divided into two separate stages. The first consists in analysis of the experimental literature, checking whether is possible to find, among experiments already carried out, a design which fits the objectives defined in the theoretical premises of the experiment (phase A of Table 3.1). If it is not possible to use or adapt a pre-existing experiment, it is necessary to devise a new experimental design. In this case, the first decision to take concerns the environment in which the experiment will be performed. There are two main ways to carry out an experiment. The first is to use material supports like envelopes, polling booths, etc.; the second is to use computers. Both empirical methods have some steps in common, while they differ as regards certain advantages and disadvantages.

The common steps are reported in the first two boxes of the "specific actions to perform" row of Table 3.1: they concern the writing of the instructions for the experimental subjects (which in the computer-aided experiments can be shown to the subjects directly on the computer screen), selecting the sample of subjects, recruiting the subjects, choosing the statistical tools with which to interpret the data, and perhaps choosing the reward for the experimental subjects. The main differences between the two methods are the claim for software for the computer-aided experiments, and the need to choose an appropriate place and procedure for the traditional ones.

Table 3.1 Phases and operating actions of an experiment

Phases	Actions to perform: General	Actions to perform: Specific
A) Theoretical definition of the topics covered by the experiment	1) Analysis of the theoretical literature 2) Building of a model	
B) Design of the experiment	1) Analysis of the experimental literature 2) Choice of the experimental environment: – traditional	t1) drafting of the instructions for the experimental subjects; t2) choice of the characteristics of the experimental subjects sample; t3) recruitment of the experimental subjects; t4) choice of the place where the experiment will be carried out (e.g. a room with pooling booths) t5) choice of the way to collect the data; t6) choice of the statistical tools to analyse the data collected; t7) choice of the reward for the experimental subjects.
	– computer aided	cp1)production of the software; cp2)choice of the characteristics of the experimental subjects sample; cp3)recruitment of the experimental subjects; cp4)drafting of the instructions for the experimental subjects; cp5)choice of the statistical tools to analyse the data collected; cp6)choice of the reward for the experimental subjects.
C) Running the experiment	1) Reception of the experimental subjects	rc1) check of the correspondence between the subjects actually present and the planned sample; rc2) briefing of the subjects and distribution of the instructions; rc3) assignment to each subject of her/his place to occupy during the experiment.
	2) Surveillance of the correct realisation of the experiment	s1) careful restraint of the subjects' behaviours during the exp.; s2) check of the correct carrying out of the operating actions.
	3) Payment of the subjects	
D) Analysis of the data collected	1) Organisation and check of the collected data base; 2) Statistical analysis	

The instructions for the participants are crucial, because each single word may affect the behaviour of participants during the experiment. It is not possible to predict with absolute precision the relationship between the formulation of the instructions and the subjects' behaviours. Consequently, the only way to proceed is to test the instructions on pilot samples of experimental subjects. In experiment ST1, a psychologist was asked to verify the instructions, which were then submitted to ten students, whose individual 'interpretations' of what they were required to do were checked. This was not a totally reliable procedure, however, because it only verified whether the instructions had a good degree of precision and whether, according to the psychologist, they were free from macroscopic undesired framing effects.

Equally important is the choice of the sample of experimental subjects. Building a good sample requires verification of whether there is any relationship between the socio-economic characteristics of the subjects and the topic studied by the experiment. When no previous experiment has been carried out on the phenomenon (or similar occurrences), it is essential to conduct one or more pilot experiments in order to ascertain the existence of these relationships. Once these tests have been carried out, the sample must be selected, keeping the socio-economic characteristics relevant to the phenomenon studied under control. In my case, I was fortunately able to benefit from the experiments described in the literature on fiscal evasion. I could therefore choose my samples (both for the one-shot and the repeated games experiments) keeping control of the only socio-economic variable that has been reported as potentially influential, namely sex (Spicer and Becker, 1980). This was done simply by building samples with the same numbers of males and females, thereby allowing direct comparison among the results from different experiments.

Recruiting the participants is probably the least complicated of the experimental phases, since care need only be taken to select a larger number of subjects than is strictly necessary for the experiment, and to store their names in a data base. The former precaution is necessary in order to avert the risk of not having enough subjects because of defections (as unfortunately happened with my first experiment ST1, when I had not recruited enough substitutes). The second device is essential if it is planned to run a group of experiments on the same topic, or, more in general, if the experiments are to be carried out in a permanent laboratory. Maintaining a data base with the names of each participant is necessary to ensure that the same subjects do not participate in experiments which need new ones: that is, subjects who have never had to deal with the specific problem treated by the given experiment. Furthermore, only if a record of the participants is available is it possible to repeat an experiment with the same subjects, when this is required by the experimental design. To date, the Experimental Economics Laboratory of the University of Trento has collected data on about 600 subjects, data which have also been used to pay the participants.

The statistical analysis of the data must be carefully planned before running the experiment, because if the experiment has not been properly designed, it may prove impossible to analyse the results. For example, if multiple analysis is considered essential for correct understanding of the results, it follows that the design of the experiment must include all the elements that may produce the desired variables.

Finally, the last stage of the design phase is choosing the reward for the participants. I used money in all the experiments described here, although in some cases other forms of payment (e.g. vouchers to spend in the University book shop) can be used. Another rather sensitive problem is how much money to give to the subjects. Fortunately, the literature suggests that the amount of money given to subjects does not seem to be an influential factor (Baldry, 1987), so that it can consequently be decided without any particular constraint. It should also be pointed out that the decision of how much money to give to the participants is obviously influenced by the amount of resources available for the experiment. If relatively small rewards are chosen, more experiments can be run, given the amount of money available for the experimental programme. Careful consideration should be made of this aspect, since it can enable investigation of more topics, or improvements in the amount and quality of the data collected.

Collecting adequate resources is another crucial point in the whole experimental process. Sometime the design of the experiment can incorporate this problem by covering topics of some interest to a sponsor (e.g. the Ministry of Finance).

Choosing the place and defining the procedure to follow when carrying out a "traditional" experiment involve the same problems as those which arise when writing the instructions for the participants. A wrong contextualisation of the experiment may in fact be due to carelessness in writing the instructions or to inaccurate definition of the routine to follow. In experiment ST1, for example, great care was taken to ensure that one condition required by the experiment - namely anonymity - would be effectively guaranteed by the procedure that the subjects had to follow. Only if a totally safe procedure had been designed could the subjects be sure that their anonymity would respected - and the experimenters sure that the results obtained were not vitiated by the uncertainty of some subjects concerning respect for the anonymity condition. Unfortunately, in this case too, as in that of the instructions, it is not possible to be absolutely sure of the total absence of some undesired frame effect. Consequently, great care must be taken during analysis of the results to evaluate whether the phenomena observed do not result from some unplanned framing effect.

Using a computer to run an experiment does not automatically solve the undesired framing effects problem. On the contrary, there is good reason to suspect that the computer by itself introduces a highly specific frame into the experiment, modifying the results in an unpredictable way. Computer-produced framing effects have been tested even in the specific field of tax evasion (Webley and Halstead, 1986), and the results seem to suggest that the use of a computer may induce subjects to consider the experiment more as a video game than as taking place in a real world context. I ran all the repeated choices experiments using computers, and I tried to check whether the degree of 'realism' might have influenced the final results of the experiment. I shall not discuss the results here, because they are reported in Chapter 5. I merely point out that every experiment, now matter how it is performed, is in some way affected by a framing effect. The artificiality of the experimental context is in fact an unavoidable limitation of this approach, and the use of envelopes, pooling booths, etc. instead of a computer screen does not solve the problem. Furthermore, I do not wish to go into the epistemological aspects of the experimental approach, since this is a topic beyond the scope of this study.

Good software for an experiment has the following characteristics:

1) it allows the experiment to be conducted without undesired interruptions;
2) it allows automatic storage of the results in a pre-organised data base;
3) it allows constant monitoring of the experiment, possibly introducing on-line corrections when these are admitted by the experimental design;

4) it keeps undesired framing effects under as close control as possible.

The software that I used is described in the Appendix. Here I shall only summarise the various steps in its production.

The name "TEMAG" (Tax Evasion Multiple Agent Game) was given to the software used for all the repeated experiments discussed here. It resulted from the following process:

1) discussion of the results from the one-shot experiments;
2) choice of objectives for the dynamic experiments;
3) choice of the computer platform (i.e. the computer operating system);
4) choice of the degree of modularity for the software;
5) first design of the software;
6) testing the software on a pre-sample of subjects;
7) final design of the software.

The purpose of the first two stages was to give precise definition to the performance that could be expected of the software. It was decided to design very flexible software which would allow the conduct of numerous different experiments and the testing of a wide variety of hypotheses. It was also decided to choose a flexible computer platform would allow the use of either work stations or personal computers. More precisely, we decided to produce software which could work with Microsoft® operating systems (DOS, Windows 95, Windows NT, etc.) as well as with the Apple Macintosh® operating system.

We also chose to develop highly modular software which could be straightforwardly adapted to completely different experiments. This decision was taken because, when we designed TEMAG, we were also planning to run a set of experiments on double auction markets in the Economics Laboratory. Consequently, we needed software which could also be used to run this kind of experiment.

Having taken all these decisions, we wrote a first prototype of TEMAG. This was tested on a pre-sample of 10 subjects who used it in a complete simulation of the dynamic experiments. This test revealed some drawbacks to the software, the most serious of which was the need to keep the local network on which TEMAG worked hermetically sealed. In fact, it was found during this first pilot experiment that someone surfing the Internet could join the experiment, sending messages to the experimental subjects and obviously ruining all our work!

The final version of TEMAG was used in all the repeated choices experiments discussed here. It did not need any further corrections, with the obvious exception of the adjustments made to take account of the specific differences required by each experiments.

Once all the stages of the design of the experiment phase have been completed, the experiment can be run. This means first of all organising the reception of the participants, checking the correspondence between their characteristics and the sample planned. Then the instructions must be distributed and the participants assisted in correct understanding of the instructions themselves. This is a crucial task because the written instructions must be interpreted in the same way by all the participants. Furthermore, no conflict must arise between the content of the written instructions and the spoken explanations given by the researchers.

For the one-shot experiments the instructions were tested on a pilot sample, while I checked the written instructions for the dynamic experiments during the pilot experiment run to test the TEMAG prototype. I was thus always able to answer the participants' questions without introducing conflict between the written instructions and their interpretation of them. Moreover, although I was helped by student volunteers (most of them were preparing their first degree theses under my supervision), I personally answered all the questions regarding all the experiments, both one-shot and repeated.

After the briefing, each subject must be assigned to her/his place, which in the case of a computer-aided experiment is a computer screen, and helped through the introductory steps of the experiment. After the briefing for the one-shot experiments, it was not necessary to give any further help to the participants, who only had to follow the procedure described in the instructions; it was only necessary to direct the operational stages.[15] In computer-aided experiments it is usually necessary to start up the software, so that some form of direct intervention by the researchers is required. In our

[15] For more detailed description of these procedures see the next chapter and the appendixes.

case, TEMAG requires only a few start operations, which were always performed before the subjects were assigned their places. Consequently, when they were sitting in front of the computer screen, they only had to follow the instructions on the screen.

In the starting stage, it is very important to prevent the participants from communicating, because any exchange of opinions about the experiment may introduce biases into their behaviour. For this reason, the subjects were carefully supervised during every stage of the experiments, and any communication among the participants was prevented. In the dynamic experiments we also positioned the computer screens in such a way that no participant could see the screen of any other participant, and was thus prevented from seeing the decisions taken by the other subjects. A further device introduced was the use small typographical characters, so that only the person directly in front of the screen could read the messages transmitted by TEMAG.

During the dynamic experiments, the Laboratory staff, under my direction, was divided into two groups: the first ensured that TEMAG was working properly; the second watched the participants in order to prevent communication and undesired behaviour.

Once the experiment has finished, the subjects must be rewarded. In our one-shot experiments this was done during the experiments themselves, because the participants were given real money at the beginning of the experiment. In the repeated choices experiments, we used the data base produced by TEMAG, which gave us a list of the rewards for each participant. More specifically, each subject was identified by a numerical code assigned automatically by TEMAG at the beginning of the experiment and which each participant wrote on a small sheet given with the instructions when the experiment began. In this way we could pay the participants only a few minutes after the end of the experiment.

Finally it should be stressed that successful conduct of experiments of this kind requires specifically trained staff. The training of staff is an important stage in the experiment, and it can be most effectively performed by involving its members in several experiments, given that some methodological problems are common to all kinds of experiments. I found it impossible to use the results from two dynamic experiments because the staff committed errors in the running phase. These errors were mainly due to the inadequate training that I was able to give to those members of the staff.

4. The one-shot experiments

4.1. The design of experiment ST1

Experiment ST1 was designed so that it could be performed using four groups of participants each consisting of 16 subjects. However, the sample actually used only consisted of 60 subjects because 4 of those selected did not come to the meeting and not enough substitutes had been recruited. The groups were as follows:

- group A, total absence of moral constraints;
- group B, only collective moral constraint (social blame);
- group C, only subjective moral constraint;
- group D, collective and subjective moral constraints.

The presence or absence of a collective moral constraint was realised respectively by conducting a public tax audit (obviously restricted only to those extracted), or by assuring total anonymity to all participants independently of their choices. The presence-absence of a subjective moral constraint was realised by introducing a system of partial redistribution of the tax yield among the participants.

The assumptions implied by these operating definitions are the following:

A_1) subjective (Kantian) moral constraint: participants dislike the idea that someone may suffer because of their behaviour (tax evasion reduces the total yield and therefore leaves less money for the final redistribution);

A_2) collective (social) moral constraint: participants believe that the other agents involved in the experiment (researchers, fellow participants) firmly condemn tax evasion.

Assumption A_1 seemed reasonably realistic because the participants were undergraduate students, and we imagined that the idea of stealing money from their fellows would be a good *morally* based deterrent against tax evasion (see the definitions of moral constraints). For a similar reason, we also believed that they would be concerned (assumption A_2) about the risk of being detected as potential 'criminals' by their teachers and fellows.

Summarising we have:

- group A, total anonymity, absence of any redistribution of tax yield;

- group B, public audit, absence of any redistribution of tax yield;
- group C, total anonymity, partial redistribution of tax yield;
- group D, public audit, partial redistribution of tax yield.

Each group was divided in two sub-groups which were originally intended to consist of 8 subjects.[16] These two sub-groups were distinguished by the total amount of work (number of psychological tests) done by the participants before the experiment. Each group was therefore made up of two sub-groups: the sub-group of 'heavy workers' who worked for about one hour, and the sub-group of 'light workers' who worked for approximately 30 minutes. These two sub-groups received different amounts of money as a reward for their time spent on the experiment, but they were taxed at the same tax rate. The members of the two sub-groups (heavy or light workers) were recruited on a voluntary basis: in other words, they were free to choose between heavy or light work.

We paid 60,000 Italian lire (about 27 UK pounds - 37.5 USA dollars) to the heavy workers, while the light workers received 30,000 Italian lire. A 40% tax rate was then applied to the members of both groups. The introduction of two different levels of income was intended as another device with which to check the presence-absence of an 'unfair tax' incentive to tax evasion. Since the tax rate was identical for both sub-groups, we expected that if some form of tax unfairness incentive to tax evasion was in operation, it would be stronger in the low income group than in the high income group. It is important to stress that a parallel reason for our decision to keep the tax rate constant was the need to reduce the number of participants (and consequently the experiment's total cost), while still having a number of subjects large enough to allow reasonable generalisations to be drawn.

The tax yield redistribution has been performed by using only a fraction (70%) of the total amount of money collected. I decided to redistribute only a part of the total yield for the sake of realism, that is, to simulate the burden due to administration costs. The money was then redistributed in identical individual parts among the members of the groups with redistribution. This means that if an experimental subject decided to evade, s/he was aware that s/he would participate, at the end of the experiment, in the share-out of the tax yield without having honestly contributed to building it. The fact that both heavy workers and light workers received an equal portion of the tax yield redistribution does not modify the absolute distances between the groups; on the contrary the relative difference changes, but only to a quite small extent. More precisely, in experiment ST1 the relative distance between the rewards (incomes) received respectively by the light workers and by the heavy workers fell from 50% in the without redistribution groups to 44% in the groups with redistribution, while in ST2 the distance between the rewards of the heavy and the light workers, belonging to the groups with redistribution, diminished to an even smaller extent to 42%.

After the pre-experiment phase,[17] all the participants were called on the same day at the same time and were divided into the experimental groups (A, B, C, and D). Each group was assembled in a separate room and received a different set of written instructions (described in the two appendices). The steps in the procedure common to every group were:

1) both the 'heavy workers' sub-group and the 'light workers' sub-group in each group were invited to enter a room containing a 'polling-booth';

2) each room contained two boxes on which was written "more work" and "less work";

3) a set of envelopes for each member of the heavy work sub-group was extracted from the "more work" box; a similar set of envelopes for each member of the light work sub-group was extracted from the "less work" box ;

4) each set of envelopes included:

a) a white envelope containing 60,000 lire (five 10,000 lire notes, one 5,000 lire note, and five 1,000 lire notes) for the heavy workers group and 30,000 lire (two 10,000 lire notes, one 5,000 lire note and five 1,000 lire notes) for the light workers group, and two tickets bearing an identification number;

b) two envelopes: the first labelled "ticket envelope", the second labelled "personal reward envelope", both open and joined (glued) together;

c) an envelope labelled "tax envelope" containing a piece of paper on which was written the tax rate and the amount of money that the participant should pay: specifically, light work group 12,000 liras, heavy work group 24,000 liras;

d) a paper clip;

5) each participant received the experiment instructions (see Appendix);

[16] The actual number of 'heavy workers' who participated in the experiment was 31; that of 'light workers' was 29.

[17] The phase in which the participants must perform the amount of work envisaged.

6) supplementary questions were contained in the tax envelope (see Appendix).

Finally, to heighten the realism of the decision problem, and in order to induce the participants to perceive the money that they received as a true personal income, and not as the 'prize' for a game, the experiment began with a 'job' assigned to each participant, who was asked to participants to take a quite large and demanding set of psychological tests. The participants were thus introduced to the real experiment as if it was be the final payment stage of the whole procedure. In this way, they would not perceive the money received as a prize in some totally artificial game but as real earnings for work done .

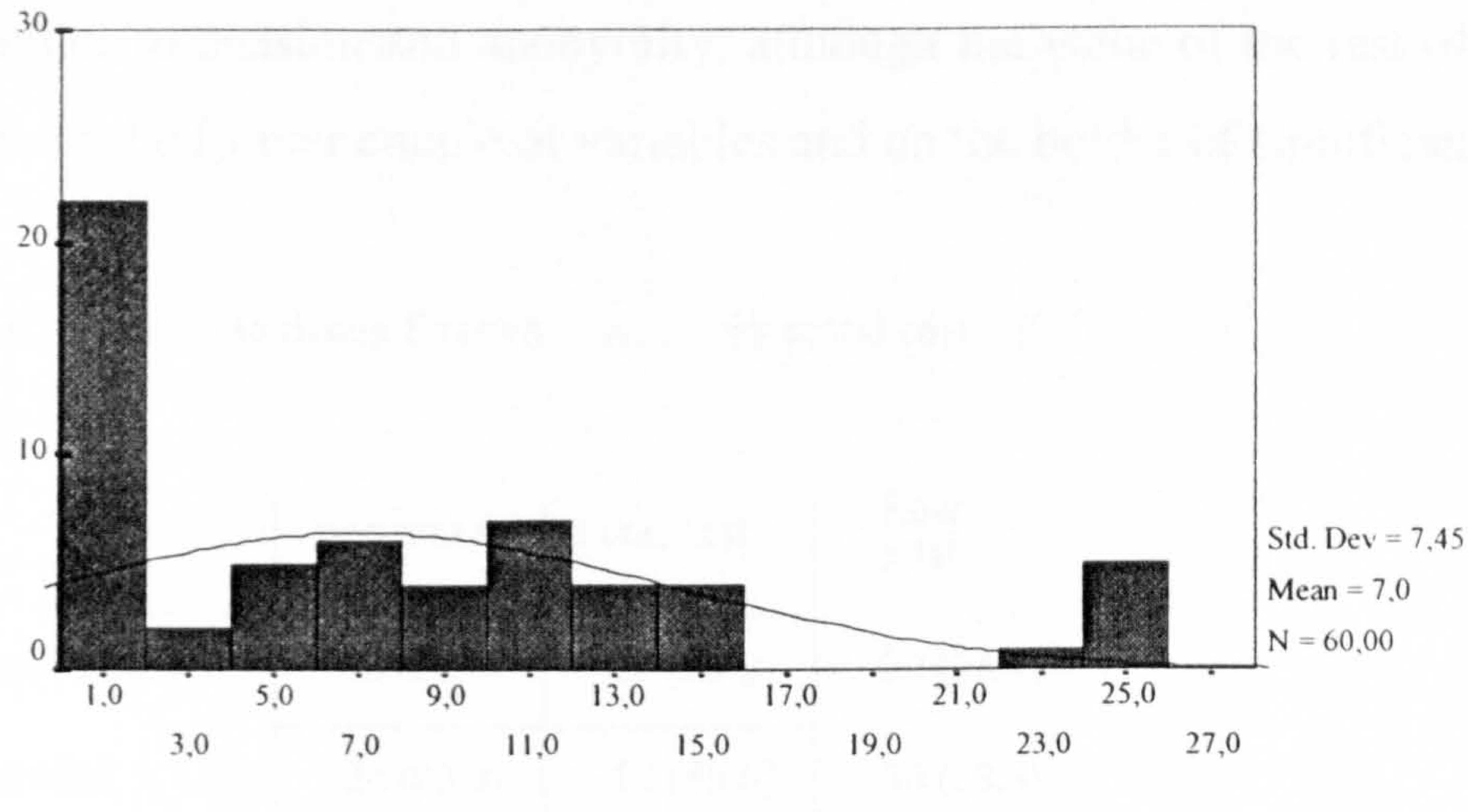
4.2 Analysis of results from experiment ST1

On 30 July 1993 the experiment was performed using a sample structured thus:

- group A (total anonymity, no redistribution of tax yield) 16 subjects;
- group B (public audit, no redistribution of tax yield) 14 subjects;
- group C (total anonymity, redistribution of tax yield) 15 subjects;
- group D (public audit, redistribution of tax yield) 15 subjects.

The number of subjects that decided to evade was 38 (63.3% of the population sample). Average evasion for the entire population was about 7,000 lire, while the average evasion for the evader sub-population was about 11,000 liras. The distribution of the amount of money evaded is given in figure 4.1.

Fig. 4.1 Tax evasion histogram (exp ST1)



On inspecting figure 4.1 it is interesting to note that there is a jump between the 15,000 lire level and the 23,000-25,000 lire levels, which represent the total evasion level for the heavy workers group. In other words, the evasion distribution does not display a continuous pattern, and there seems to be some sort of *threshold effect*: those taxpayers in the heavy workers group who decided to evade more than 15,000 lire directly jumped to the total evasion threshold, instead of choosing an intermediate level of evasion.

Most of the variables considered by the experiment are dichotomous and may at the same time have some form of dependence on one or more other variables. I first consider the role played by moral constraint simulated by the assumption of the redistribution of the tax yield, and by social blame simulated by the absence of anonymity. Preliminary analysis of the data suggests that moral cost is a real deterrent against tax evasion, while anonymity seems to be significant, although at a lower level of significance, but ill signed, as shown by Tables 4.1 and 4.2.

In the presence of a moral cost, 14 subjects (given a total of 30 subjects) decided to evade. In the absence of any moral constraint, 24 of them (again with a sample of 30 subjects) evaded. Another way to state the phenomenon is as follows: 72.7% of the total taxpayer population were included in the moral cost group. By contrast, if we look at Table 2 we find that 22 members of the non-anonymous group (which was made up of 29 subjects) decided to evade, compared with 16 in the anonymous group (31 subjects). The chi-square values seem to confirm these considerations, allowing us to reject the hypothesis of independence between the decision to evade and the moral constraint. The same applies to evasion and anonymity, although the value of the test (0.05) is weaker than it is for the former couple of variables and on the border of significance.

Tab. 4.1 Crosstabulation Evasion λ by moral cost K

λ by K	non moral cost	moral cost	Row total
has not evaded	6 (20.0)	16 (53.3)	22 (36.7)
has evaded	24 (80.0)	14 (46.6)	38 (63.3)
Column total	30 (50.0)	30 (50.0)	60 (100)

Chi-square - 7.17 sig. 0.007

Tab. 4.2 Crosstabulation Evasion λ by anonymity S

λ by S	non anony mous	anonymous	Row total
has not evaded	7 (24.1)	15 (48.3)	22 (36.7)
has evaded	22 (73.3)	16 (51.6)	38 (63.3)
Column total	29 (48.3)	31 (51.7)	60 (100)

Chi-square - 3.79 sig. 0.05

From this preliminary analysis it therefore seems that anonymity was not perceived by the subjects as a deterrent against fiscal evasion,[18] while the moral constraint worked as a rather powerful disincentive. The problem is now is to devise a better test of the validity of this consideration, controlling that the dependence between these two variables is a 'clean' phenomenon, and not a spurious one induced by one (or more) other variables. Before addressing this problem, which is of central importance for all further analysis of the data, it is advisable to give some more results.

[18] The perverse sign of the artificial variable 'anonymity', which is confirmed by the result of multiple analysis, suggests that students are not particularly worried by the prospect of being detected as evaders by teachers and colleagues. They instead feel the incentive to evade as a proof of courage.

A second interesting issue to explore is the following: is it the expected probability of being audited or is it the income level that influences the decision to evade? In this case too, I shall use a simple cross-tabulation to examine these matters.

Tab. 4.3 Crosstab. Evasion λ by expected audit probability $\hat{\pi}$

λ by $\hat{\pi}$	prob. < 0.2	prob. > 0.2 < 0.5	prob.> 0.5	Row total
has not evaded	10 (47.6)	8 (25.8)	4 (50.0)	22 (36.7)
has evaded	11 (63.2)	23 (74.2)	4 (50.0)	38 (63.3)
Column total	21 (35.0)	31 (51.7)	8 (13.3)	60 (100)

Chi-square = 3.27 sig. 0.194

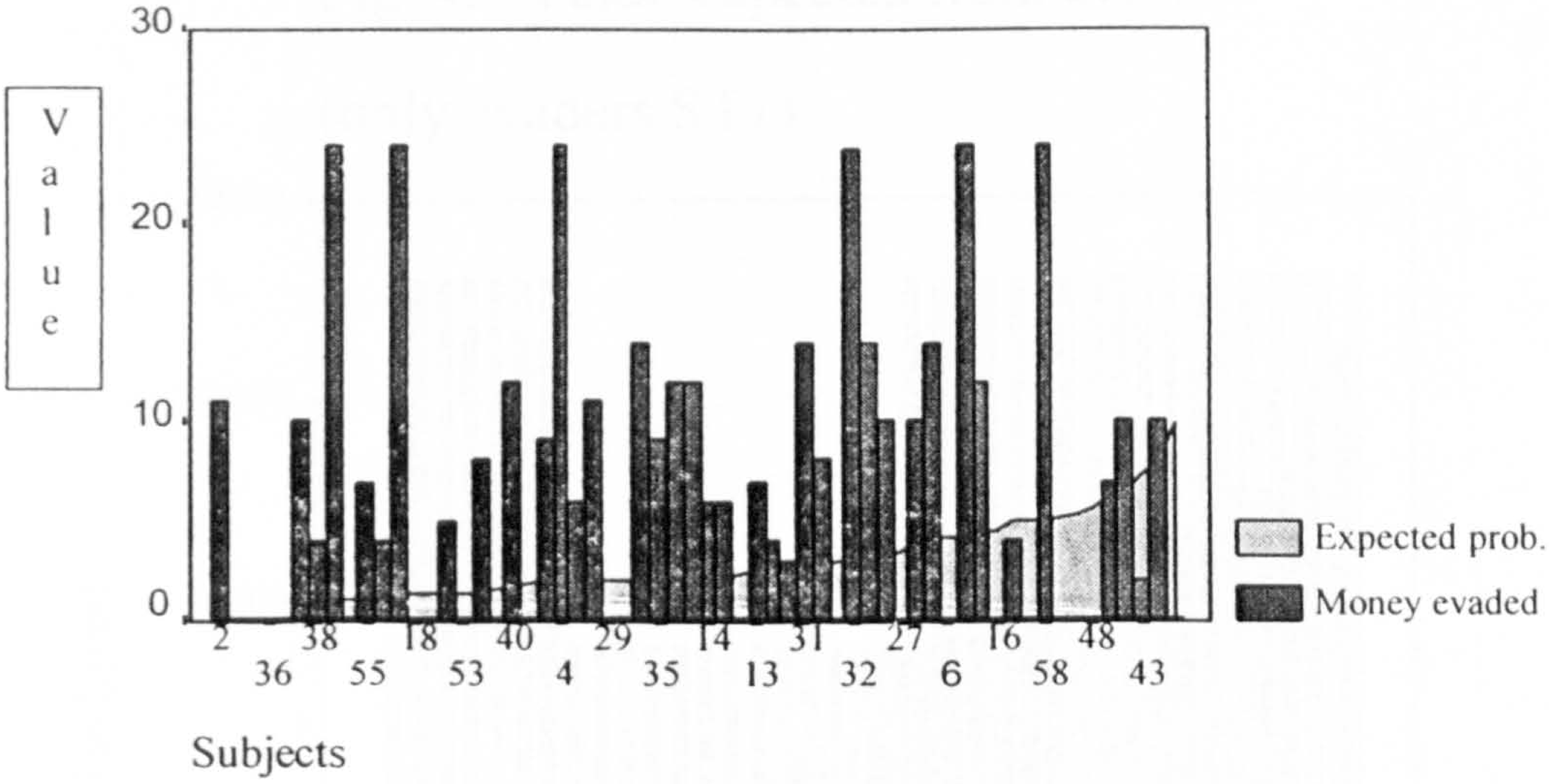
The expected audit probability has been transformed from the 1-7 scale to a 0-1 traditional scale, and the continuous variable thus obtained has been converted into a three-level variable (expected probability lower than or equal to 0.2; expected probability between 0.21 and 0.5; expected probability greater than 0.51)[19].

It is rather difficult to interpret the results set out in Table 4.3 because the subjects' behaviour tends to change in a quite curious manner: the propensity to evade seems to be similar for those subjects belonging to the two extreme levels (low expected probability and high expected probability), while it rises quite dramatically for subjects who believed that they had a moderate probability of being audited. Table 3 has 11 evaders out of a total of 21 subjects for the low probability level, while the 8 subjects at the high probability level are exactly divided between evaders and honest taxpayers.

A similar result is also shown by the graph in figure 4.2 which plots the expected probability of being investigated (drawn as an area) and the amount of money evaded by subjects.

[19] Obviously, the possible number of levels and kinds of interval for the conversion of expected audit probability into a discrete variable can be various. In fact, I have also tried a second transformation that keeps the number of subjects included in each level constant. Since the results are not significantly different, they are omitted for reasons of space: the interested reader is referred to the working paper version of this article.

Fig. 4.2 Expected audit prob. and evasion

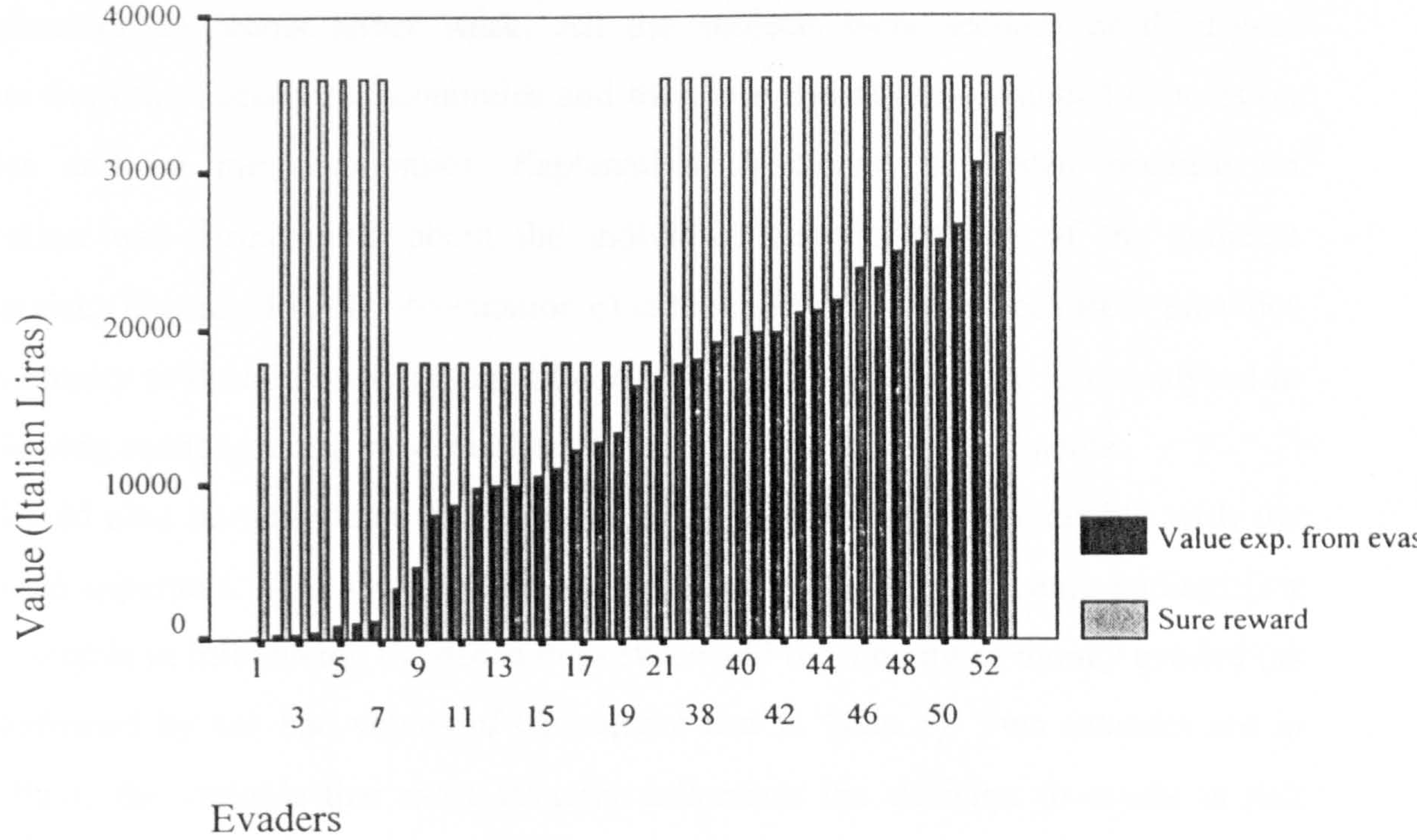


The numeric values of the"value" axis are referred to money evaded

Figure 4.1 confirms the phenomenon just observed in Table 4.3. One notes, in fact, that the amount of money evaded does not seem strictly related to subjective forecasts of being investigated. Note in particular that six subjects in the heavy workers group decided to evade the entire amount of tax due, and that four of them are divided between the lower part (two of them forecast a probability lower than 0.14) and the higher part (two of them believed that the risk of being investigated had a probability higher than 0.42) of the expected probability distribution. An even better picture of this phenomenon can be obtained if we plot (Fig. 4.3) the expected value from evasion computed using the expected audit probability declared by the participants that decided to evade.

Fig. 4.3 Value expected from evasion

(only evaders ST1)



The interesting phenomenon exhibited by fig. 4.3 is that all the evaders decided to evade even if their expected probability of being audited - obviously combined with the penalty - gave an expected value from evasion that was always lower than that offered by the sure choice - that is, the net reward after taxation. One can envisage three main explanations for this phenomenon:

a) the subjects completely ignored any criteria when computing the expected value;
b) all of these subjects were risk-takers, i.e. they took pleasure from making the risky choice;
c) some 'psychological' factor and/or the mental process followed to compute the expected audit probability induced the ST1 subjects to make an apparently bad choice.

Obviously, these three explanations can be combined, since they are not necessarily antagonistic.

Unfortunately, the experiment gives little insight into the predominance of one explanation over the others; but the applied psychology literature provides a great deal of evidence that the behaviour observed is not uncommon.

Explanation a) seems rather weak. All the subjects were second- or third-year students from the Faculty of Economics and therefore had already attended courses on statistics and on microeconomics. Explanation b) cannot be tested because no information was forthcoming about the individual generic attitude of the subjects towards risky choices. Finally, explanation c) is the most interesting because it provides an opportunity to discuss a wide range of considerations which will be also analysed in the following sections using the data obtained from the dynamic experiments.

It should also be noted that these results do not seem easily reconcilable with the theoretical apparatus. This suggests that the expected probability of being audited is a 'poor' variable in influencing the decision to evade and the amount of money evaded (as also confirmed by the bad values of Chi-square test in table 3). Two remarks are in order. First, the variable that most strongly influences the decision to evade is risk aversion, and not expected audit probability. This means that it is perfectly rational to evade if the agent has a high expected audit probability but a low risk aversion - that is, if s/he is a risk taker.

On the other hand, it is interesting that there is a certain degree of similarity between my result concerning expected probability and the result of the survey conducted by the Italian Exchequer, which was used to design the experiment.[20] The results concerning expected audit probabilities reported by Exchequer's survey (the question was: "What, according to you, is the probability that you will be audited by the tax inspectors?) are the following:

less than 1% = 36.8

between 1% and 10% = 22%

between 11% and 30% =18.2%

between 31% and 50% = 11.8%

between 51% and 80% = 5.5%

[20] In the Italian Exchequer' survey the question to answer was: "which do you believe is the probability that you will be audited by the fiscal police?"

more than 80% =4.5%

missing = 1.3%

If we add the percentages of respondents who believed that they had less than a 30% chance of being audited, we obtain a total of 77% of respondents. Going back to the results from ST1 we discover that 66.6% of the sample was made up of subjects who had an expected audit probability lower than 31%. Therefore, the beliefs of the two samples are broadly similar, and this is particularly true of subsets with between 1% and 30% expected audit probability. These subsets have a cumulative percentage of 40.2% for the Ministry's sample and of 50% for my sample, while the other subgroups show very different cumulative percentages.[21] The Italian Exchequer's data therefore seems to show that my subjects' beliefs sufficiently approximated some sort of 'common sense' or 'collective realistic' forecast of expected audit probability as believed by the sample of citizens analysed by the Italian Government.

Turning to income level, it should be borne in mind that only two income levels were planned. Consequently, in this case too, a 2x2 cross-tabulation can be used, as in Table 4.4.

From analysis of Table 4.4 it seems that there is a quite close relationship between income and tax evasion: richer subjects tend to evade more than poorer ones do. More precisely the "heavy workers" subgroup has a 77% tax evasion rate while only 48% of "light workers" have decided to evade.

From the experimental design we know that the definition of moral constraint rests on the assumption that subjects perceive the (partial) redistribution of the tax yield among participants as a fairness device. More precisely, we assume that participants dislike the idea that someone may suffer because of the reduction in total yield due to their decision to evade.

[21] The lower than 1% subset accounted for 36.8% of the Exchequer's interviewees compared with 10% of mine sample; the greater than 31% subset includes 21.8% of the Ministry's sample, while in my case subjects included in that subset represent 33.3% of the entire sample.

Tab. 4.4 Crosstabulation Evasion λ by income levels Y

λ by Y	light workers (poor)	heavy workers (rich)	Row total
has not evaded	15 (51.7)	7 (22.6)	22 (36.7)
has evaded	14 (48.3)	24 (77.4)	38 (63.3)
Column total	29 (48.3)	31 (51.7)	60 (100)

Chi-square = 5.48 sig. 0.019

The problem is that another effect produced by redistribution is an increase in total legitimate income, so that this change may be directly interpreted by subjects as an income component, and not as a separate factor. This suspicion is reinforced by the fact that redistribution can be seen as a sort of public good financed out of the tax yield. As we have seen from the literature review, the provision of public goods can have a negative effect on evasion when the size of the community is not too large.[22] This means that once we assume that the number of tax payers is infinitely large, the provision of public goods does not change the level of evasion. On the contrary, if the size of the community is relatively small, taxpayers believe that evasion will decrease her/his consumption level of public goods.

One way to address this problem is to produce a further 2x2 cross-tabulation between the decision to evade and the level of income, splitting the sample into two subsets: respectively with or without moral constraint. The results are given in Tables 4.5 and 4.6. The most important result shown by these tables is the inversion of light worker (poor people) subgroup percentages. In the absence of moral constraint the majority

[22] If we suppose that there is a single homogeneous public good, the utility function is: U{C,G}; where G is the level of consumption of public goods. The government budget constraint is the following:

$G \leq \frac{\sum_{i=1}^{N} (1-\lambda_i) t Y_i - \phi(\pi)}{\psi(n)}$; where $\phi(\pi)$ is the cost to the government of enforcing the probability of detection π, and $\psi(n)$ is the constant marginal rate of transformation of the private consumption good into the public good. $\psi(n)$ is a non decreasing function of n and satisfies the following conditions (Cowell, 1990): $1 < \psi(n) \leq n$, $\lim_{n \to \infty} 1/\psi(n) = 0$, $\lim_{n \to \infty} \psi(n)/n = \overline{\psi} > 0$. The extreme value $\psi(n) = n$ corresponds to the case of completely rival goods and $\psi(n) = 1$ corresponds to the case of absolutely non-rival goods. For the sake of simplicity, I shall further assume that all taxpayers are identical and that people are not satiated with public goods. Given these assumptions it is easy to show that the optimal value of evasion is now:

$$\lambda^* = \frac{(1-\pi)U'_C\{Cs\} - \pi P(\lambda)U'_C\{Ca\}}{\pi P'(\lambda)U'_C\{Ca\}} - \frac{U'_G[1/\psi(n)]}{\pi P'(\lambda)U'_C\{Ca\}}.$$

(66.7%) of light workers decided to evade, whereas in the presence of moral constraint the evaders dropped to only 28.6% of the total subset. Also heavy workers tend to evade more in the absence of moral constraints but the majority of this subgroup is always clearly made up by evaders. On the other hand, it should be stressed that in the absence of moral constraint only one subject in the heavy workers sub-group refused to evade, while in the presence of moral constraint six members of this group decided to pay all their taxes. Supposing that subjects perceived what we consider to be a moral constraint only as an increase in their expected legal income, or as an increase in their level of consumption of the redistribution-public good, the results seem point to the conclusion that if the amount of legally-earned money is increased, people tend to reduce their propensity to evade.

Tab. 4.5 Crosstabulation Evasion λ by income levels Y controlled by K = 1 moral constraint

λ by Y	light workers (poor)	heavy workers (rich)	Row total
has not evaded	10 (71.4)	6 (37.5)	16 (53.3)
has evaded	4 (28.6)	10 (62.5)	14 (46.7)
Column total	14 (46.7)	16 (53.3)	30 (100)

Chi-square = 3.45 sig. 0.063

Tab. 4.6 Crosstabulation Evasion λ by income levels Y controlled by K = 0 moral constraint

λ by Y	light workers (poor)	heavy workers (rich)	Row total
has not evaded	5 (33.3)	1 (6.7)	6 (20.0)
has evaded	10 (66.7)	14 (93.3)	24 (80.0)
Column total	15 (50.0)	15 (50.0)	30 (100)

Chi-square = 3.33 sig. 0.068

The problem is that this phenomenon conflicts with the fact that rich subjects always have an higher evasion rate than poor ones. Furthermore, poor subjects tend to raise their evasion rate proportionally more than rich ones do when the moral constraint is removed.

Summarising, there is no strong argument to conclude that the tax yield redistribution was perceived only as an income effect or was correctly (from the point of view of our assumptions) interpreted by subjects. More careful analysis is required of the data, therefore, and probably more information is also required - that is, a more complex questionnaire should have been administered to our subjects.

4.3 Multiple analysis (experiment ST1)

In previous sections I performed simple two dimensions analysis to investigate the possible relationships between the variables. A further step in the statistical analysis is to try to verify if there is some form of multiple relationship among the variables considered by the experiment.

In this specific case, we can imagine a quite complex interaction among the variables. Recalling our hypotheses, we should investigate the existence of some form of multiple relationship between the decision to evade, the amount of money evaded and the following variables:

a) the income level;

b) the moral constraint (yield redistribution);

c) anonymity;

d) expected probability of being audited;

e) expected rate of evasion;

f) resentment at someone else's evasion.

I shall begin investigation of these relationships by ignoring the amount of money evaded. In other words, I shall imagine that the decision to evade is some sort of *two-*

step process: first the subject decides whether to evade or to pay and then decides the amount of money to evade. Our task is therefore to estimate a model with a dichotic rather than a continuous dependent. As is well known, one of the most widely used statistical techniques in these cases is logistic regression analysis,[23] which was used to estimate the following model:

$$\lambda = f(\hat{\pi}, K, S, Y, \Psi, \hat{\mu}) \qquad [4.1]$$

where:

λ = evasion (binary variable);
$\hat{\pi}$ = expected audit probability (continuous variable);
K = moral constraint (binary variable);
S = anonymity (binary variable);
Y = income level (binary variable);
Ψ = disappointment at knowing that someone has evaded (continuous variable);
$\hat{\mu}$ = expected rate of evaders (continuous variable).

The assumptions for the model are basically the same as those discussed in previous sections. However, brief comment is required to justify the inclusion in the model of Ψ and $\hat{\mu}$. Both these two variables are expected to be proxies of the perceived social attitude towards evasion that, as seen in the theoretical analysis, should play an important role in the decision to evade. More precisely, strong resentment at the knowledge that someone has evaded should be a proxy for a very strong moral attitude, while a high expected rate of evasion should go in the opposite direction, signalling the belief that the prevailing social attitude is in favour of evasion.

These are the results obtained by the logistic regression:

[23] As well known (Amemiya, 1985) the logistic regression analysis or *logit model* is defined by $P(y_i = 1) = F(x'_i\beta_0)$, with i =1,2, ...,n where $\{y_i\}$ is a a set of dichotomous independent variables, β_0 is a vector of unknown constants and F is a known function. In logit models F(x) is equal to $\lambda(x) \equiv \frac{e^x}{1+e^x}$, which is a distribution function similar to the normal distribution but characterised by a much simpler form.

-2 Log Likelihood	53.542		
Goodness of Fit	53.787		
Model Chi-Square	25.317	6 (df)	0.0003 (signific.)

Variable	B	S.E.	Wald	df	Sig	Exp(B)
$\hat{\pi}$	1.7981	2.0168	0.7948	1	0.3726	6.0381
$\hat{\mu}$	1.8000	1.4227	1.6006	1	0.2058	6.0496
Ψ	-2.0500	1.1806	3.0153	1	0.0825	0.1287
K	-1.4477	0.8030	3.2501	1	0.0714	0.2351
S	-1.4896	0.7385	4.0682	1	0.0437	0.2255
Y	1.6300	0.7423	4.8222	1	0.0281	5.1041
Constant	1.0222	1.0838	0.8895	1	0.3456	

The model has an 80% overall percentage of correct prediction: more specifically, 63.64% of the non-evasion cases observed were correctly foreseen by the model, and 89.47% of the observed evaders were correctly predicted.

To evaluate the statistical significance of the explicative variables I used the Wald statistics, that are computed as the square of the norma "t statistics" and are therefore asymptotically distributed as chi square with one degree of freedom[24]. Looking to the values of Wald statistics we can see that only the coefficients for Y and S seem to be significantly different from 0 using a significance level of 0.05. The coefficients for K and Ψ are on the border of significance, while $\hat{\pi}$ and $\hat{\mu}$ should be removed from the model.

Finally, it is worth noting that the signs of the parameters are all coherent with our assumptions.

If $\hat{\pi}$ and $\hat{\mu}$ are excluded from the model, we obtain the following results:

-2 Log Likelihood	56.196		
Goodness of Fit	52.629		
Model Chi-Square	22.662	4 (df)	0.0001 (signific.)

[24] For more information on Wald statistics (Wald, 1943) see Amemiya (1985) p.142. A weakenss of this test is that it has been designed to work with large samples of data, which is not exactly our case.

Variable	B	S.E.	Wald	df	Sig	Exp(B)
Ψ	1.6570	1.0206	2.6359	1	0.1045	0.1907
K	-1.8563	0.7477	6.1632	1	0.0130	0.1563
S	-1.4571	0.7029	4.2977	1	0.0382	0.2329
Y	1.7401	0.7222	5.8048	1	0.0160	5.6977
Constant	2.2178	0.8035	7.6188	1	0.0058	

The overall percentage of correct prediction of the model has fallen to 75%, and the Wald statistics signal that Ψ should be removed by the model. It therefore seems advisable to test a further model by including only S, K and Y.

These are the new results:

-2 Log Likelihood	58,927		
Goodness of Fit	54,332		
Model Chi-Square	19,932	3 (df)	0.0002 (signific.)

Variable	B	S.E.	Wald	df	Sig	Exp(B)
K	-2.0506	0.7117	8.3007	1	0.0040	0.1287
S	-1.5285	0.6863	4.5999	1	0.0259	0.2169
Y	1,7829	0.6932	6.6162	1	0.0101	5.9474
Constant	1.6850	0.6965	5.8523	1	0.0156	

The overall percentage of correct prediction of this new model is 73.33%. The likelihood ratio has increased, and the Wald statistics suggest that K is the most explanatory of the three variables included in the model, followed by Y, while the weakest variable is S. The good performance of this reduced model therefore seems to confirm the importance of the moral constraints introduced in the experiment, and the comparatively weaker role played by the extra-experimental moral factors monitored by means of the questionnaire.

Regardless of this conclusion, it is interesting to test a diametrically different model which includes only the extra-experimental moral variables together with Y.

The results are as follows:

-2 Log Likelihood	61.224		
Goodness of Fit	61.682		
Model Chi-Square	17.635	3 (df)	0.0005 (signific.)

Variable	B	S.E.	Wald	df	Sig	Exp(B)
$\hat{\mu}$	2.7530	1.2732	4.6753	1	0.0306	5.6893
Ψ	-2.0797	0.9585	4.7077	1	0.0300	0.1250
Y	1.3831	0.6451	4.5967	1	0.0320	3.9871
Constant	-0.3122	0.7747	0.1624	1	0.6870	

The overall percentage of correct prediction for this model is 78%. The value of the model chi-square test allows rejection of the null hypothesis that the coefficients for the exogenous variables (excluded the constant) are 0. The Wald statistics for all the variables included are reasonably good, and finally all the signs of the coefficient confirm our theoretical premises. From these results, and assuming that Ψ and $\hat{\mu}$ are true proxies for the perceived social attitude toward evasion, we may conclude that each individual's *ethical system* influenced the decision to evade, as well as the artificial constraints introduced by the experiment. This conclusion is unsurprising because the design of the experiment did not enable exclusion of the effects exerted by subjective, psychological factors embodied in the cultural histories of our subjects. The important point is that both Ψ and $\hat{\mu}$ can be interpreted as alternatives to K and S, reinforcing the conclusion that the moral factors do indeed play an important role in determining the decision to evade.

I also ran a traditional OLS regression using the first reduced model and replacing the dependent dichotomous variable with the amount of money evaded. The OLS results - reported in appendix A3 (section 6.3) - show that this model has rather weak explanatory power. Nevertheless, the starting hypotheses and the results just obtained using the logistic regressions seem broadly confirmed, although in this case it is K rather than Ψ which plays the leading role as a deterrent against evasion. Finally, it is worth pointing out that the third reduced model used in the logistic regressions - that is, EVAS = $f(\hat{\mu}, \Psi, Y)$ - yields worst results if compared with the former one.[25]

4.4 The implications of ST1

The results obtained by experiment ST1 seemingly confirm most of the initial theoretical hypotheses and reveal one major unexpected phenomenon. More precisely, the two variables analysis showed that only one of the two moral constraints considered influenced the behaviour of our subjects and that the amount of the reward given was the more influential factor. This conclusion is in part weakened by the multivariate analysis, which suggested that the moral constraint (the redistribution of the tax yield) was less important than other cultural factors not directly checkable by the experiment. The most important of the unforeseen results is fact that, more than the *artificial* moral constraints introduced by the experiment, it was some sort of *natural*, cultural constraint which operated as a deterrent against evasion.

A final consideration concerns the static nature of this experiment, which is a serious limitation on the context examined. The decision to evade is in fact a typically dynamic phenomenon, because taxes must be paid every year and because audits are generally conducted on several tax declarations. It should be therefore of great interest to conduct a similar experiment but in repetitive form.

4.5 The design of the experiment ST2

The design of the ST2 experiment is identical to that used in ST1, with two important changes:

1) in the ST1 experiment the subjects did not know the probability of audit, while in ST2 this information was given to the subjects;

[25] The R^2 descends to 0.34, the EXPEVAS variable is not significant, and REGRET is on the border of

2) in the ST1 experiment the subjects did not know that the tax rate was the same for every participant, while in ST2 the subjects knew that they were being treated equally - that is, they would all be taxed at the same tax rate.

Another difference between the two experiments concerns the questionnaire, which was enlarged in ST2 to include a new set of questions (see Appendix).

The ST2 experiment had two aims: the first was to check the role played by uncertainty about tax audit probability; the second was to verify the effects of uncertainty with regard to the level of the tax rate applied to the other participants. In the former case the intention was to overcome the difficulties encountered in the ST1 experiment to explain the role played by the expected probability of being audited. Similarly, also the second theme - namely the role played by the perceived fairness of the tax rate investigated - was prompted by the ST1 experiment. In the ST1 experiment the participants were unaware of the tax rate applied to the other players and might therefore have thought that they were being unfairly discriminated against. This doubt was reinforced by the quite high tax rate adopted in ST1, which may have induced the subjects to suspect that they were being harshly taxed without any equity guarantee concerning the treatment of the other participants.

It was decided to repeat the ST1 experiment in Milan because of the availability of financial support from the Catholic University in that city. The objection that distortions may have been produced by conducting the experiments in two different cities and universities is unfounded. The participants in both experiments came from almost identical socio-economic backgrounds: they belonged to middle-class families, they were second- and third-year university students, and they were resident in Northern Italy.

4.6 The analysis of results of ST2: a first overview

The ST2 experiment was performed using a sample consisting 64 students from the faculties of economics and law and structured as follows:

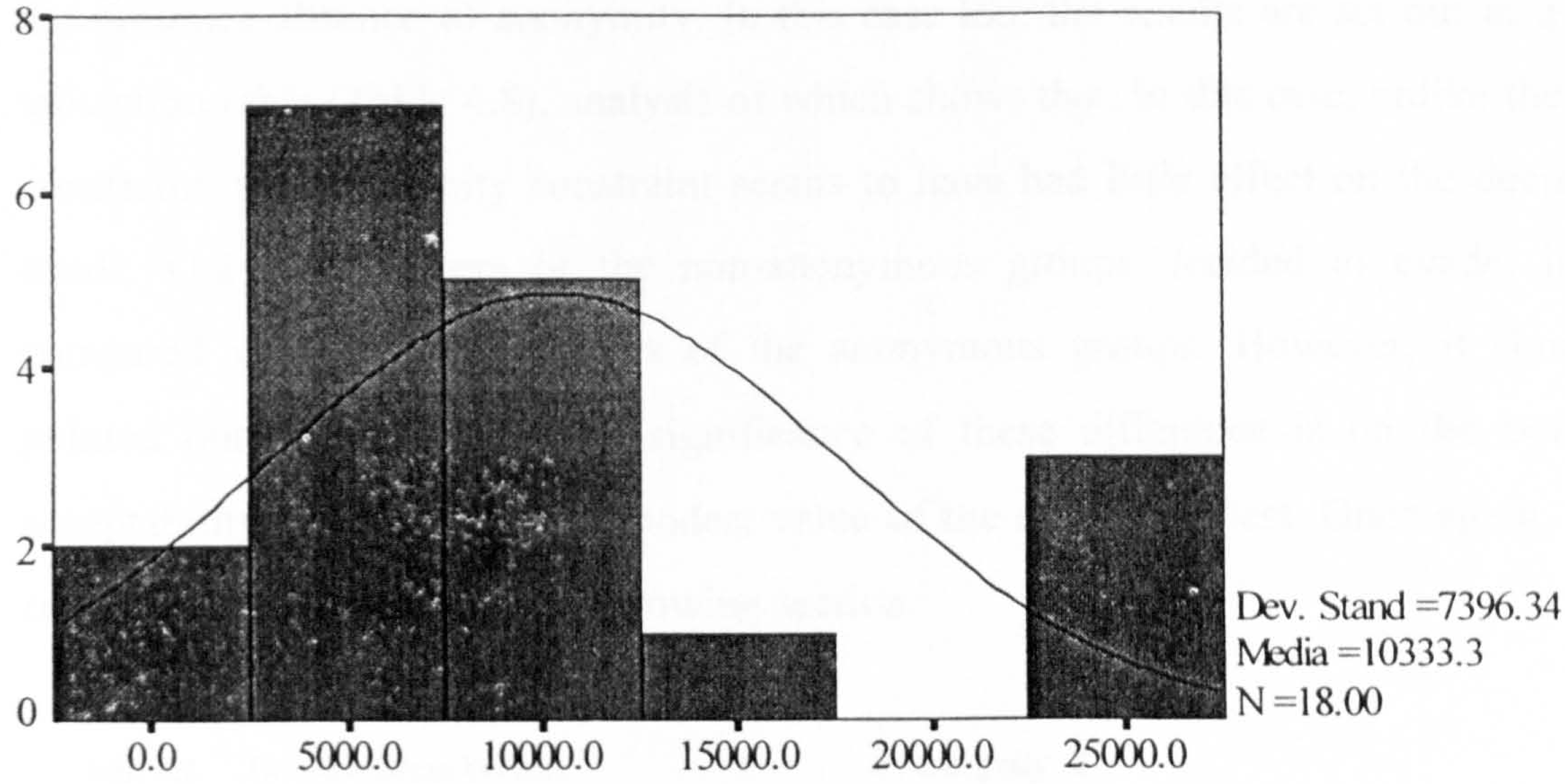
acceptability.

- group A (total anonymity, no redistribution of tax yield) 16 subjects;
- group B (public audit, no redistribution of tax yield) 16 subjects;
- group C (total anonymity, redistribution of tax yield) 16 subjects;
- group D (public audit, redistribution of tax yield) 16 subjects.

As in the ST1 experiment, the members of each group were divided into two sub-groups: the so-called *heavy workers* group and the *light workers* group, each made up of 8 subjects. Again following in the ST1 design, the members of these two sub-groups received different amounts of money as rewards for the differing amounts of time that they had spent on the experiment.

The total number of evaders in ST2 was 18, and the distribution of the amount of money evaded is shown in fig. 4.4. The figure highlights that also in ST2, as previously noted in ST1, there is some sort of jump from the 13,000-15,000 lire level to the total evasion level, which is 24,000 lire for members of the heavy workers group. In this sample too, therefore, it is possible to discern the same threshold effect as observed in the ST1 experiment. However, the 15,000 to 24,000 lire level is not the only threshold in the ST2 sample, as it was in the ST1 sample, because there was also a second threshold between 7,000 and 13,000-15,000 lire. Obviously, there is no reason to suppose that the amount of money evaded by participants should approximate a normal distribution. Hence the existence of jumps need not be interpreted as something necessarily unusual. However, the presence of thresholds may signal that the decision to evade - at least within this experimental context - has been taken as if it were based on a discrete set of amounts of money.

Fig. 4.1 Tax evasion histogram (ST2)



Analysis of the effects exerted by the first moral constraint considered by the experiment - namely the 'moral cost' represented by the redistribution of the tax yield - is assisted by Table 4.7, which gives the cross-tabulation between evasion and the presence-absence of redistribution. The most important information yielded by Table 4.7 is the equal distribution of evaders between the groups with and without the moral constraint. This finding refutes one of the central theoretical assumptions of the original model, and it is in open contrast with the results from ST1. These considerations are crucial, and for this reason they will be discussed after this first overview of the results.

Tab. 4.7 Crosstabulation Evasion λ by moral cost K

λ by K	non moral cost	moral cost	Row total
has not evaded	23 (71.9)	23 (71.9)	46 (71.9)
has evaded	9 (28.1)	9 (28.1)	18 (28.1)
Column total	32 (50.0)	32 (50.0)	64 (100)

Chi-square = 7.17 sig. 0.007

Again following the ST1 experimental design, the second constraint considered was the presence-absence of anonymity. In this case too, the results are set out in a cross-tabulation table (Table 4.8), analysis of which shows that, in this case, unlike the moral constraint, the anonymity constraint seems to have had little effect on the decision to evade. Only 7 members of the non-anonymous groups decided to evade, in fact, compared with the 11 members of the anonymous groups. However, it should be pointed out that the statistical significance of these difference is on the border of acceptability, as shown by the modest value of the chi-square test. Once again, I shall comment on this result in the following section.

Tab. 4.8 Crosstabulation Evasion λ by anonymity S

λ by S	non anony mous	anonymous	Row total
has not evaded	25 (78.1)	21 (65.6)	46 (71.9)
has evaded	7 (21.9)	11 (34.4)	18 (28.1)
Column total	32 (50.0)	32 (50.0)	64 (100)

Chi-square = 3.79 sig. 0.05

The third important factor included in the experimental design was income level. Table 4.9 shows that the evaders belonging to the light workers groups were slightly larger in number than those belonging to the heavy workers group. Note that here the statistical significance of the relationship between the two variables considered is even weaker than it was in the case of anonymity and evasion. It also interesting that once again the results from the ST2 sample are different from those observed in ST1.

Tab. 4.9 Crosstabulation Evasion λ by income levels Y

λ by Y	light workers (poor)	heavy workers (rich)	Row total
has not evaded	22 (68.8)	24 (75.0)	46 (71.9)
has evaded	10 (31.3)	8 (25.0)	18 (28.1)
Column total	32 (50.0)	32 (50.0)	64 (100)

Chi-square = 5.48 sig. 0.019

4.7 Comparing the results of ST2 with the ST1 experiment

Summarising the results just presented and comparing them with those obtained from the ST1 experiment, the main findings concern:

a) *number of evaders*: in the ST1 experiment there were 38 evaders out of a total of 61 subjects, whereas in the ST2 experiment there were only 18 evaders out of a total of 64 subjects;

b) *"moral" constraint (redistribution of the tax yield) effect*: in the ST2 experiment this constraint had no influence at all on the subjects' behaviour - the 18 evaders were exactly divided between the groups with and without redistribution of the tax yield - while in the ST1 experiment redistribution of the tax yield led to a marked reduction in tax evasion;

c) *anonymity effect*: whereas in the ST1 experiment this constraint did not have any strong effect on the subjects' behaviour, in the ST2 experiment it apparently exerted some influence, because the number of evaders was slightly higher in the anonymous groups (11 subjects) than in the non-anonymous ones (7 subjects).

The findings from the ST2 experiment, as anticipated in the previous section, seem somewhat discouraging *vis-à-vis* the theoretical premises. Nevertheless, they can be usefully interpreted if we consider the two differences introduced into the ST2 experiment, namely removal of uncertainty about a) the audit probability and b) the other participants' tax rate. Both points a) and b) are important for explanation of the differing results obtained from the two experiments. I shall begin with the first difference - that is, the higher rate of evaders in ST1.

From a neo-classical theory perspective, deciding to evade, when knowing the objective probability of being audited, or when adopting a subjective forecast of such a probability, should induce the same decision-taker to make different choices only if these probability measures - the objective one and the subjective one - differ. Likewise, and this time from a probability theory perspective, two random samples extracted from the same population of decision-takers should display the same frequency distribution of the attitude towards risky choices. Assuming that the samples are from the same population - a reasonable assumption given the selection criteria used - this means that we should expect an increase in audit probability - whether subjectively or objectively measured - to produce a reduction in the number of evaders. This is wholly contradicted by the results from the two experiments: in ST1 the average expected audit probability was 28%, 9 points higher than the declared audit probability used in ST2, where there were about 80% fewer evaders than in ST1.

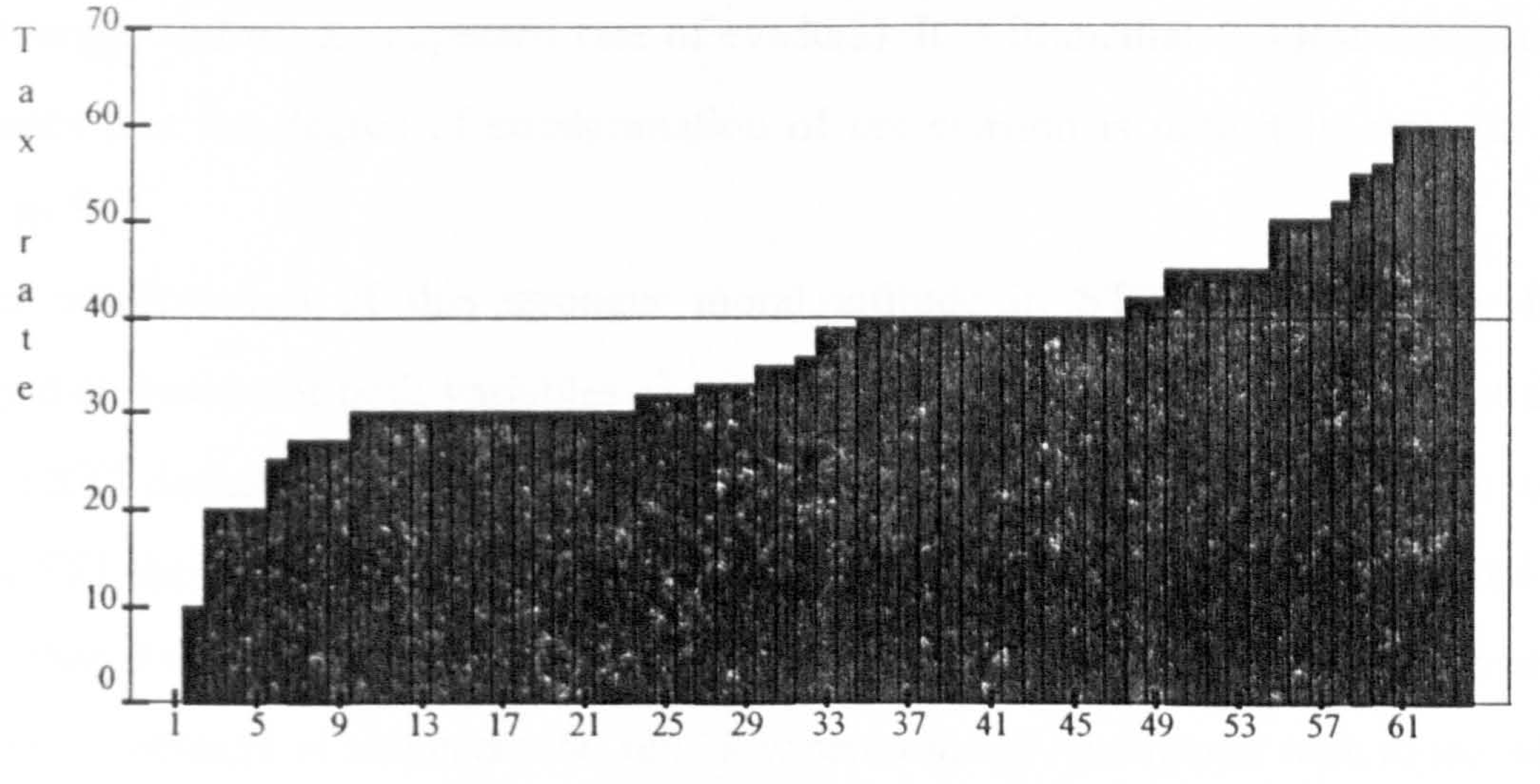
This result seems to signal the important role played in the decisional budget by direct information - "three people from your group of 16 will be audited" - instead of a generic signal - "some of you may, or may not be audited". The validity of this interpretation is further reinforced by the apparently irrational behaviour of the ST1 subjects in their subjective forecasting of the audit probability. One of the difficulties arising in the analysis of the results from the ST1 experiment was, in fact, the frequent absence of any apparently rational relationship between the decision to evade (and the amount of money evaded) and the expected subjective audit probability declared by the subjects during the experiment. In the ST1 experiment, ignorance of the real risk run seems therefore induced the 'dangerous' decision to evade. Obviously, this statement requires confirmation, and it cannot be taken as constituting a definitive result.

Equal to, if not more important than, audit probability is the knowledge of the rules used by the researchers to decide the tax rate level. Each individual subject in ST1 may have thought that s/he was being unfairly taxed - remember the very high tax rate adopted in the experiment (40%) - while her/his experimental fellows were subject to lighter fiscal pressure. This belief can act as a powerful incentive for fiscal evasion, and the suspicion that many of the ST1 subjects regarded the 40% rate as unfair fiscal pressure is confirmed by comparison between fig. 4.4 and fig. 4.1, which reveals that in ST1 there was a much larger number of evaders who decided to evade small 'symbolic' amounts of money (44% of evaders evaded less than 9,000 lire, which is slightly more than 3 ½ pounds, and there is also the extreme case of a subject who decided to evade only 2000 lire - about 80 pence) than in ST2. This explanation of the different evasion rates in the two samples seems to be supported by the different behaviour of the 'rich' subjects in ST1 and ST2.

In ST1 the percentage of evaders belonging to the heavy workers group was higher (77%) than the percentage of evaders belonging to the light workers group (48%). By contrast, in ST2 the percentage of evaders belonging to the rich group was lower (25%) than that of the evaders belonging to the other group (31%). Now, imagine being a poor-light worker player in the ST1 experiment. In that context you will not know the tax rate used by the researchers to tax your richer fellows. It is therefore reasonable for you to suppose that they are being taxed at an even harsher tax rate, according to a generic equity criterion such as the one applied in the real world. In this case you may therefore believe that the high tax rate is not a problem of *individual* discrimination against you, but a more general one common to all the participants in the experiment. Conversely, in the ST2 experiment environment you will be perfectly aware that the rich players are subject to the same tax rate as you are. You may therefore interpret this decision by the researchers as unfair with respect to a common-sense idea of fiscal equity. It follows, as seemingly demonstrated by the results, that it is reasonable to expect an higher percentage of evaders among the poor subjects in ST2, and the opposite in ST1.

On the other hand, we may suppose that the subjects evaluated the degree of fairness of the tax rate used in the experiment on the basis of their experience of the real world. In this case, the subjects should compare what they believe to be the prevailing tax rate in society with the tax rate applied in the experiment. Unfortunately, this information was known only for the ST2 sample, because in ST1 the subjects were not asked about this point. In ST2 the question was: "In your opinion, what is the prevailing *average* tax rate in Italy?". The structure of the replies is shown in fig. 4.5, from which we learn that in ST2 48.6% of the respondents (one was absent) believed that the average tax rate in Italy was equal to or higher than the rate adopted in the experiment. This percentage rises to 51.7% if we also include those who believed that the average Italian tax rate was 39% of income. This result therefore seems to show that in ST2 there was a prevailing belief that the researchers had adopted some sort of realistic criteria in determining the tax rate. Obviously, this consideration goes some way towards explaining the relatively low rate of evaders in ST2.

Fig. 4.5 Supposed average tax rate in Italy (ST2)



Much more difficult to explain is the apparently total failure of the 'moral' constraint (redistribution of the tax yield) in ST2, and the relatively stronger role played by anonymity. A possible explanation is provided by the results from the regression analysis conducted on the ST1 data. This revealed that, more than the *artificial* moral constraints introduced in the experiment (anonymity and tax yield redistribution), what actually influenced the decision to evade were the subjects' personal (declared) opinions of the fairness of evasion as social behaviour. In other words, I discovered that the non-evaders in ST1 were those who felt some form of moral condemnation of tax evasion. The effects of this cultural value may then have been reinforced by the experimental moral constraints or, in some cases, the former may even have been replaced by the latter. In any case, this *extra-experimental* moral value was one of the factors that most closely influenced the experimental subjects' decisional balances in ST1.

Assuming the validity of this analysis, is any confirmation of its accuracy provided by the ST2 data? Two questions were used to measure the subjective feeling of rejection of evasion in both ST1 and ST2: "how many of the other participants do you think will evade taxes?" and "how much do you resent the fact that some of the other participants have decided to evade their taxes?". The assumption implicit in these questions is that if a participant believes that only a very few people will evade, and if s/he feels strong resentment on discovering that many of her/his fellows have decided to evade, s/he will also strongly condemn tax evasion. Figures 4.6 and 4.7 respectively report the ST1 and ST2 distributions of Ψ (degree of resentment), transformed from the original range 1-7 to a 1-10 range, and of $\hat{\mu}$ (expected rate of evaders). It is immediately clear from both these figures that the degree of condemnation of tax evasion is definitely stronger in ST2 than in ST1.

Further confirmation of this stronger moral attitude in ST2 is provided by the frequency distribution of both variables $\hat{\mu}$ and Ψ, from which we find that 61% of the subjects in ST2 declared a value for Ψ equal to or higher than 5 (the admitted range was 1 to 7). In ST1 the percentage of subjects who declared that they felt resentment equal to or greater than 5 was only 27%, while 36.7% declared that they felt only low resentment (in ST2 the percentage of subjects who felt "low resentment", compared with those who decided to evade, was only 12.5%). Likewise, with regard to the expected rate of evasion, one notes that there was a lower expected rate of evaders in ST2 than in ST1: for example, in ST2 the cumulative percentage of subjects expecting that more than the 30% of subjects would evade was 43%, while in ST1 this percentage was 53%. We may conclude from these results that the *endogenous moral constraints* against tax evasion were more powerful in ST2 than in ST1.

Fig. 4.6 Degree of resentment ST1 and ST2

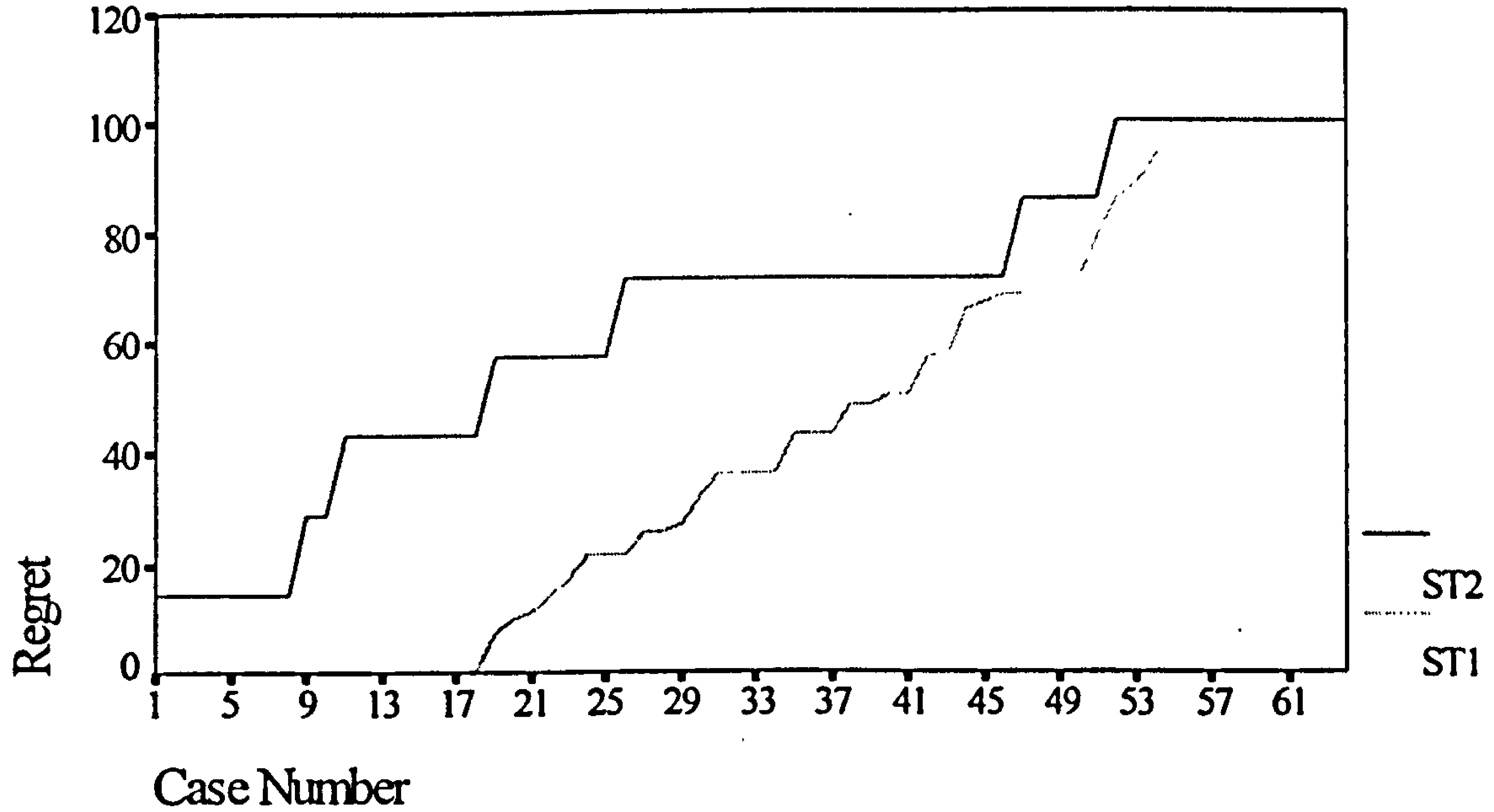
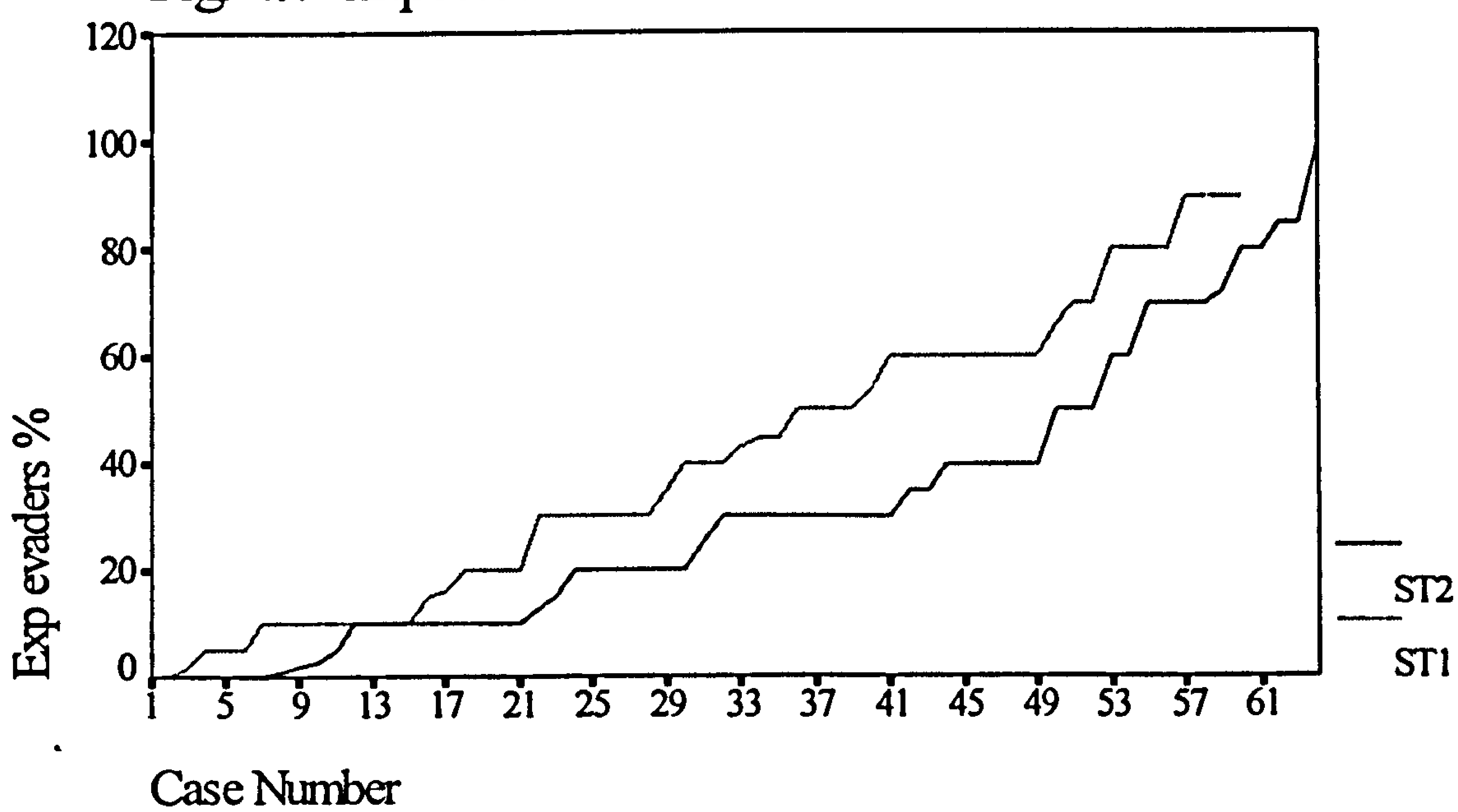


Fig. 4.7 Expected evasion ST1 and ST2



If this interpretation is accepted, we can straightforwardly explain both the weak effect produced in ST2 by the artificial moral constraint represented by the redistribution of the tax yield, and the comparatively (with ST1 results) stronger effect exerted by anonymity. It is clear, in fact, that in the presence of a strong moral *endogenous* attitude against tax evasion, the *artificial* enforcement introduced by the experiment plays a very marginal role. At the same time, anonymity may be viewed as some sort of easy emergency escape for those who, knowing that they were among virtuous puritans (remember that the ST2 experiment was conducted at the Catholic University), nevertheless decided to evade.

4.8 Multiple analysis (ST2)

Better understanding of the results from the two-variables analysis performed in the previous section, and improved understanding of the differences between the two experiments, may be yielded by multivariate analysis.

Following the analytical method already adopted when commenting on the ST1 experiment, I estimate a slightly simplified version of the [4.1] model:[26]

$$\lambda = f(K, S, Y, \Psi, \hat{\mu}) \qquad [4.2]$$

These are the results obtained from the logistic regression:

-2 Log Likelihood	64.014		
Goodness of Fit	67.979		
Model Chi-Square	12.034	5 (df)	0.0343 (signific.)

Variable	B	S.E.	Wald	df	Sig	Exp(B)
$\hat{\mu}$	0.0299	0.0125	5.6919	1	0.0170	1.0304
Ψ	-0.2544	0.1909	1.7762	1	0.1826	0.7754
K	-0.0021	0.7110	0.0000	1	0.9977	0.9979
S	0.6462	0.6303	1.0511	1	0.3053	1.9083
Y	-0.1773	0.6235	0.0809	1	0.7761	0.8375
Constant	-1.1363	1.0441	1.1846	1	0.2764	

[26] The only difference is that in this case I have excluded the expected probability of being audited from the model.

The model has a 81% overall percentage of correct prediction, but the results of Wald statistics signal that none of the explicatives, excepting for $\hat{\mu}$ (i.e. the expected rate of evaders), are related to the dependent. Despite the weakness of the model, the final result is coherent both with the considerations that emerged from the two-variables analysis and with the results obtained from the ST1 experiment. In ST2, too, the most influential moral factor seems in fact not to have been the "artificial" constraints introduced in the experiment, but the "natural" ones represented by one of the proxies of the participants' "central values system". From this point of view the greatest difference with respect to the ST1 results is the weakness of Ψ.

Confirmation of these results can be obtained by running an OLS regression using the amount of money evaded as dependent and $\hat{\mu}$ and Ψ as only explicatives. These are the results:

Multiple R	0.41621				
R Square	0.17323				
Standard Error	5633.12742				
	DF		Sum of Squares	Mean Square	
Regression	2		398929673.38582	199464836.69291	
Residual	60		1903927469.47132	31732124.49119	
F =	6.28590		Signif F =	.0033	

Variable	B	SE B	Beta	T	Sig T
$\hat{\mu}$	67.456822	28.045376	0.286119	2.405	0.0193
Ψ	-836.204347	383.343577	-.259482	-2.181	0.0331
(Constant)	4606.259689	2172.630783		2.120	0.0381

The percentage of the dependent's variance explained by the model is very low - only 17% - but the sign and the significance of the T statistics confirm the importance of both $\hat{\mu}$ and Ψ. None of the other possible explicatives, including both those considered in model [4.1] and others, such as sex and degree of knowledge of fiscal topics (binary variable obtained by asking the participants if they have attended a course on Public Finance), shows any significant relationship with the dependent.

5. The dynamic experiments

The main issues that emerged from the one-shot experiments are the following:
1. The subjects' perception of risk and their attitude towards it, as shown in fig. 4.3, can be explained by looking at the nature (subjective versus objective) of audit probability;
2. The psychological frame has a significant influence on taxpayer behaviour.

From these insights I extracted some questions that I decided to explore using a set of repeated choices experiments:

Q_1) Does the possibility of playing more than once change the subjects' attitude towards risk and consequently towards fiscal evasion?
Q_2) Does the more effective of the two moral constraints introduced in the one-shot experiments (i.e. tax yield redistribution) play any role in a repeated choices frame?
Q_3) Can one identify some form of learning process which teaches the subjects how to cope with risk?
Q_4) Does the context (the simulation of a fiscal environment) have any effect on the subjects' behaviour?

In order to find an answer to these questions I ran five dynamic experiments, which are discussed in this chapter. I start with a description of the parts of the experimental design that were common to all the experiments.

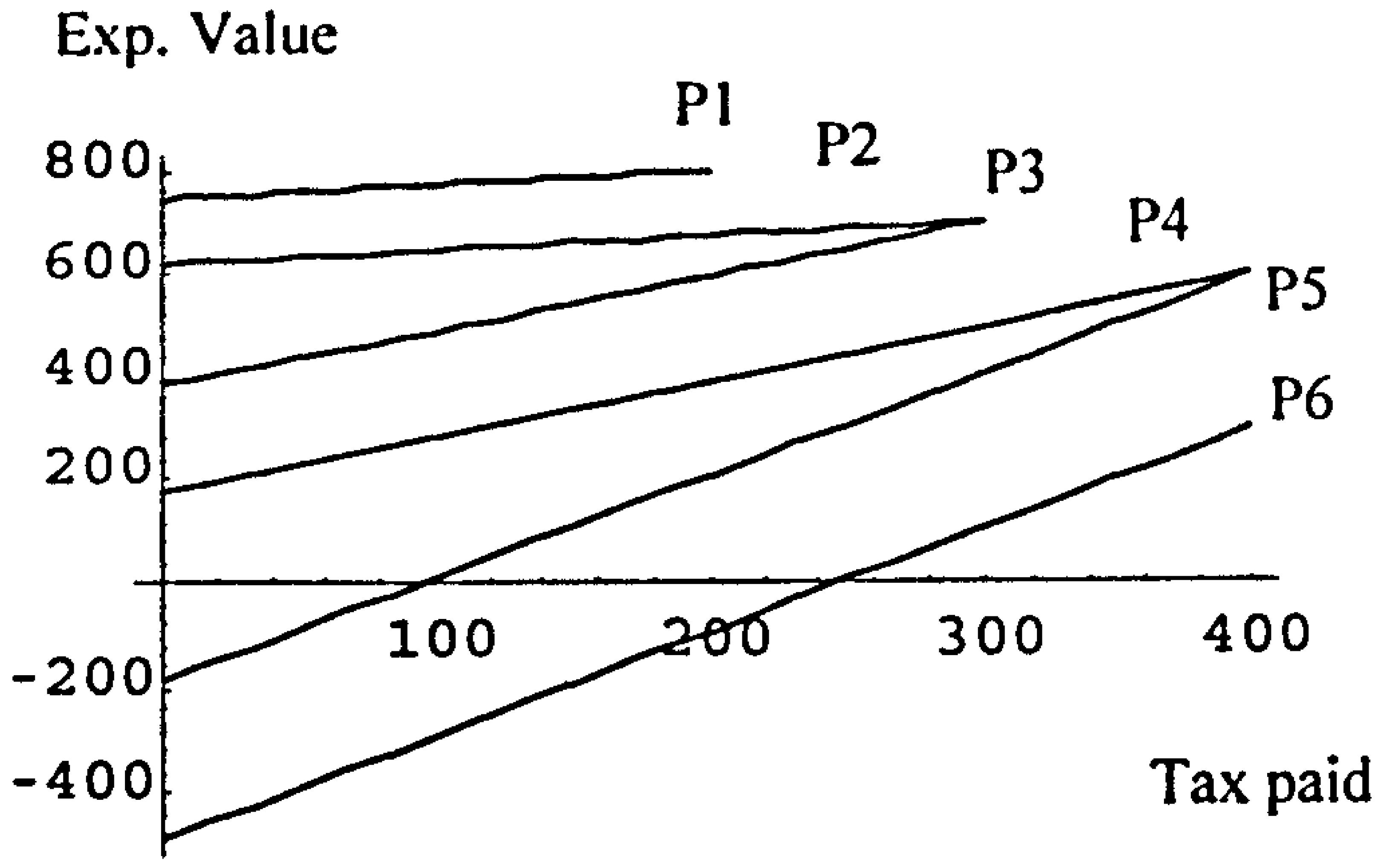
5.1 The design of the dynamic experiments

The dynamic experiments were run using a computer-aided game designed for this specific purpose with the help of a computer scientist from the Computable and Experimental Laboratory of the University of Trento. The software architecture is described in the appendix. Thirty subjects participated in each experiment (15 men and 15 women, students from the Faculty of Economics of the University of Trento). All the experiments were of the same length (60 rounds, a duration that was communicated to the subjects) and they were run by taking the variables that enter the lottery structure as constant. The values for the lottery were the following:

a) *income* - 1000 Italian liras from round 1 until round 48, then 700 Italian liras;
b) *tax rate* - 20% from round 1 until round 10, then 30% from round 11 until round 30, and finally 40% from round 31 until the end;
c) *tax audit probability* - 6% from round 1 until round 21, then 10% from round 22 until round 40, and finally 15% from round 41 until the end (the individual probability of being audited was independent of the other subjects' probabilities of being audited, and the players were informed of this characteristic);
d) *fees* - the amount of the tax evaded plus a fee equal to the tax evaded multiplied by 4.5; the tax audit had effect over the current round and the previous three rounds.

To approximate a real life situation more closely, I decided to extend the tax audit over a period of four rounds. For this reason, and as the lottery structure changed during the experiment, computation of the expected value from evasion was rather more complex than it was for the one-shot experiments. To calculate the expected values for the different lotteries I used a simple program produced using *Mathematica*© and reported in the appendix. The graphic result from the simulation is shown in fig. 5.1, in which the horizontal axis represents the tax paid and the vertical axis represents the expected value from evasion. Fig. 6 demonstrates that the lottery structure for the dynamic experiments was always unfair. As the one-shot lottery was a more than fair lottery, I expected the percentage of evaders in the dynamic experiments to be smaller than it was in the one-shot ones. Obviously this consideration was valid only for the first round of the game.

Fig. 5.1 Expected values for the dynamic experiments



P1: income=1000; tax=20%; audit prob.=6%
P2: income=1000; tax=30%; audit prob.=10%
P3: income=1000; tax=40%; audit prob.=10%
P4: income=1000; tax=40%; audit prob.=15%
P5: income=1000/700; tax=40%; audit prob.=15%
P6: income=700; tax=40%; audit prob.=15%

During the experiment the players were not allowed to communicate, and they received information only from the computer screen, which showed the following items of information:

a) the total net income earned by the player since the beginning of the game,
b) the gross income of the active round,
c) the amount of taxes to pay in the active round,
d) the number of the active round,
e) the number of players that decided to evade in the previous round (as a percentage).

Item e) was not information really produced during the experiment, because it was provided to the subjects using a pre-built data base, which was kept identical for all the experiments. This device was introduced in order to test the players' reactions in a controlled and constant environment and to allow comparisons between different experiments. For the same reason the subjects were divided into two groups, and they underwent a fiscal audit in correspondence to the same rounds (specifically rounds 13, 31, 34, 48, 54, 58 for the first group and rounds 3, 24, 27, 40, 46, 50 for the second group). I decided to include information e) and f) with the aim of enhancing the 'realism' of the experiments.

A further information device in the experiment took the form of a snap interruption: the computer screen changed and a message appeared informing the subjects that the audit probability would change after three rounds (this item of information kept the subjects constantly informed about the relevant parameters of the lottery). When each subject had read the information on the screen and had taken her/his decision, s/he wrote, using the computer keyboard, the amount of money that s/he had decided to pay and then waited to see if s/he had been extracted for a fiscal investigation.

As said, the dynamic experiments were designed to test some specific hypotheses; this task was performed by introducing the following differences to the original design:

DY1) was the standard experiment;

DY2) was the same as DY1 but with the introduction of the tax yield redistribution (which was one of the 'moral' factors investigated in the one-shot experiments);

DY3) was the same as DY2, except that the tax yield was used to finance the provision of a public good (the creation of a scholarship fund);

DY4) was exactly identical to the standard experiment, except that it was designed as a generic gamble and every reference to the fiscal environment was eliminated (I shall call it the "gamble experiment" for convenience);

DY5) was the only experiment with a different lottery structure and a different timing of the fiscal audits.

I shall give more details of the structure of the experiments in the following section, when I discuss the results.

5.2 The aggregate results

This section provides a picture of the results from the dynamic experiments by means of graphs obtained from the subjects' aggregate behaviour for the entire duration of each experiment. Before starting the analysis of the graphs, it is helpful to look at the number of evaders computed for the first round of each experiment and at the total tax yield produced:

Table 5.1 Evaders and tax yield (repeated choices experiments)

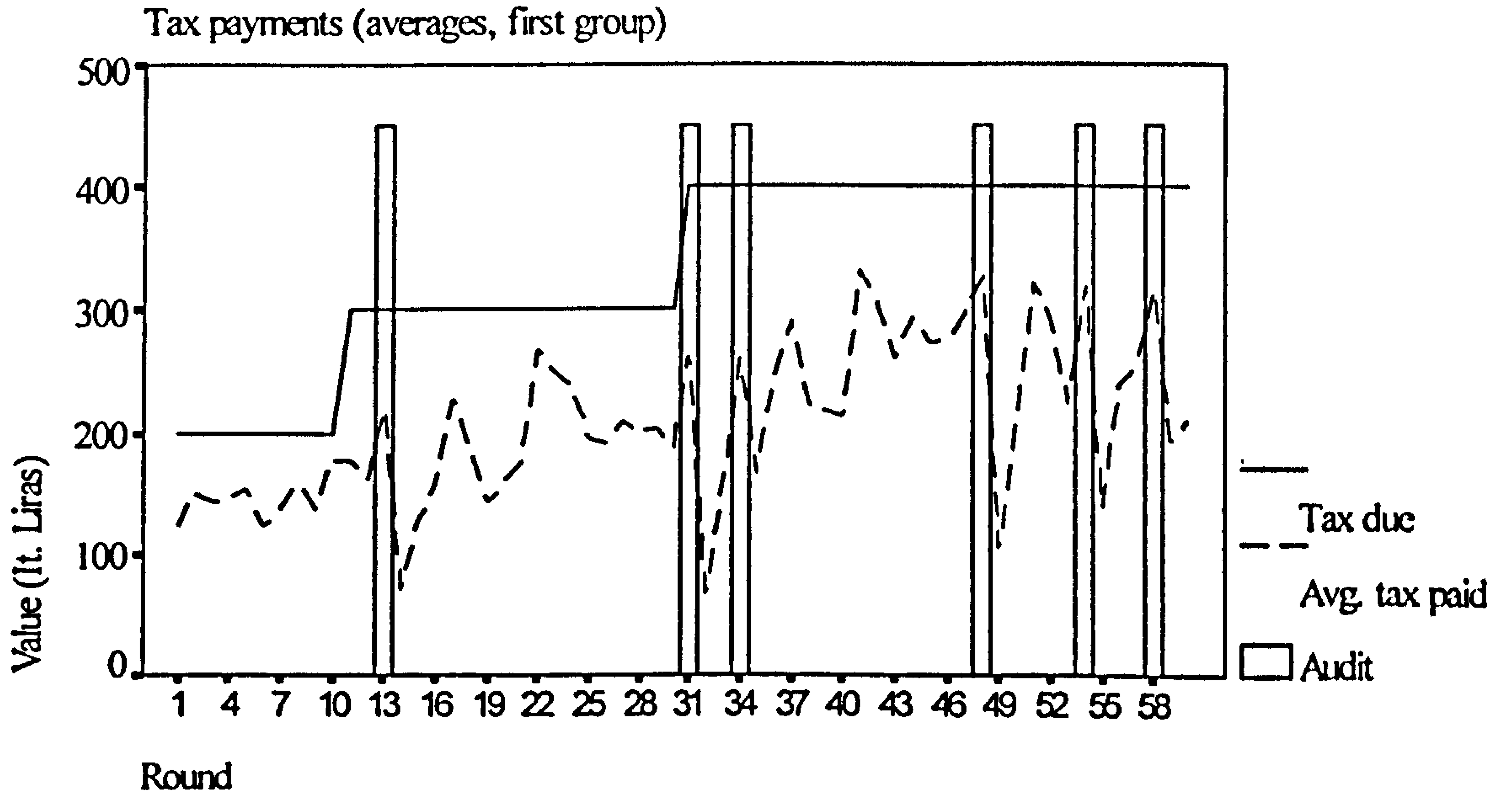
Experiment	Number of evaders (first round)	% of evaders (first round)	Number of evaders	total tax yield (Italian liras)
DY1	14	46.0%	951	393,519
DY2	12	40.0%	499	495,345
DY3	16	53.0%	715	467,021
DY4	19	63.3%	1012	397,524
DY5	15	50.0%	-	-

The first consideration that arises from Table 5.1 is that the percentages of evaders in the first round for all the repeated choices experiments were much higher than that reported in the one-shot experiment with objective audit probability (in experiment ST2 evaders were only 28.2% of the total sample). Since the starting lottery of all the dynamic experiments was unfair, while the lottery in ST2 was more than fair, this result is once again rather difficult to explain on the basis of expected utility theory, unless we hypothesise that the subjects in ST2 had strong risk aversion while in all the dynamic experiments they were not risk averse.

The second consideration concerns the number of evaders (or more precisely the number of times that someone has decided to evade during the whole experiment) and the total tax yield collected at the end of the experiments. The differences confirm the importance of the moral constraint already tested in the one-shot experiments. Both the experiment with tax yield redistribution (DY2) and the one with a public good financed from the tax yield (DY3) produced a higher tax yield than was collected in the standard experiment (DY1) and in the gamble experiment (DY4). Similarly, also the number of evaders was noticeably lower in the experiments with redistribution (499) and with a public good (715) than in those without any moral constraint (respectively 951 evaders for the standard experiment and 1012 for the gamble experiment). These results therefore seem to confirm the anti-evasion effect exerted by some psychological factor implied by the redistribution of the tax yield either in the form of money or as a public good.

The graphs from experiment DY1 are reported in fig. 5.2 and 5.3, which show the dynamic of the subjects choices.

Fig. 5.2 Standard experiment (DY1)



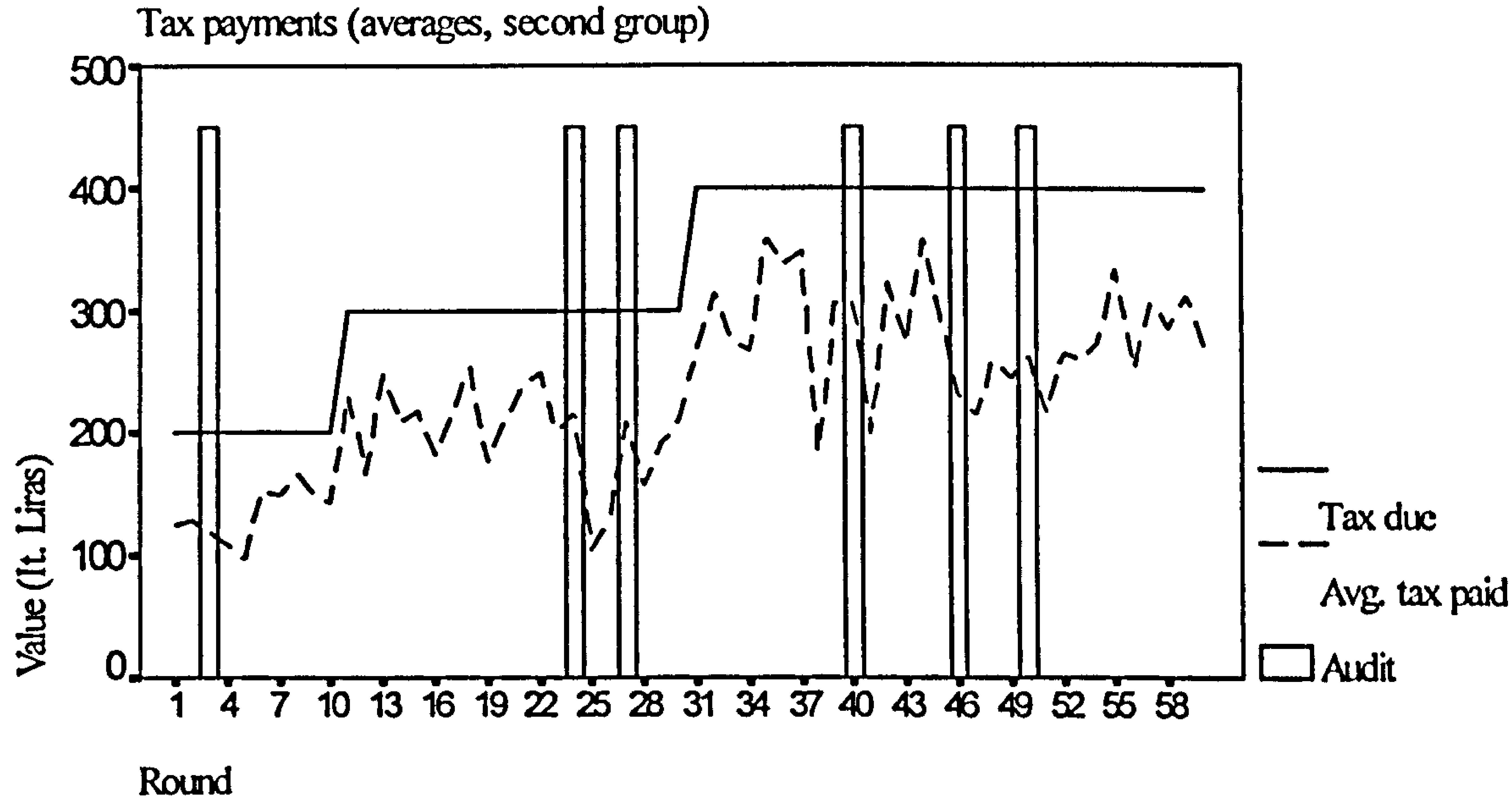
Two considerations arise: the first is that it is rather difficult to interpret these choices in the light of traditional expected utility theory; the second is that the evolution of the aggregate choices is apparently unaffected by modifications to the lottery structure. If the usual Von Neumann Morgenstern approach is used to interpret the dynamic observed, a very unrealistic hypothesis must be introduced, namely that there is a large proportion of subjects who are risk neutral (given the different lotteries) and who consequently choose the amount of money to pay in each round at random. This latter consideration can be evaluated better by looking at two periods of the DY1 experiment, i.e. from round 11 to round 30 and from round 31 to round 48. During these periods all the influential variables of the lottery were constant, except for the audit probability, which changed at rounds 21 and 40. Dividing these two periods into four sub-periods: rounds (11-21); (22-30); (31-40); (41-48), and computing for each sub-period the average tax-yield per round, we obtain the following values:

(sub-group A - rounds 11-21 - tax audit = 6%) - average tax yield per round 5,610.3
(sub-group B - rounds 22-30 - tax audit = 10%) - average tax yield per round 6,032.2
(sub-group C - rounds 31-40 - tax audit = 10%) - average tax yield per round 7,608.5

(sub-group D - rounds 41-48 - tax audit = 15%) - average tax yield per round 8,458.9

The increase in the average tax yield from A to B is 7.5%, as opposed to an increase of 66% in the audit probability. The tax yield increase from C to D is 11.1% while the increase in the audit probability is 50%. It follows that the effects on tax evasion exerted by the increase in the tax audit probability are very small.

Fig. 5.3 Standard experiment (DY1)



A clearer picture of the subjects' behaviours, with respect to the probability of being audited and fined, is given by figs. 5.4 and 5.5, which show the average expected values computed by using the lotteries chosen by the two sub-groups of subjects that participated in the standard experiment. It will be seen that the expected values for both the two sub-groups are always lower than the value of the corresponding sure choice (i.e. to pay taxes), and the amount of money evaded seemed unrelated to the trend of the expected values. By contrast, there is a negative correlation between the amount of money evaded and the value of the sure choice (the linear correlation coefficient between the value of the sure choice and the average tax paid by the first group of subjects is -0.48 and -0.36 for the second group, with a significance level of 0,000 for the first coefficient and 0.004 for the second). This relationship is coherent with expected utility theory because is rational to evade less when the value of the sure choice is high and more when it decreases, assuming a constant risk propensity.

Fig. 5.4 Standard Exp. (DY1)

Expected values from lottery (avg. first group)

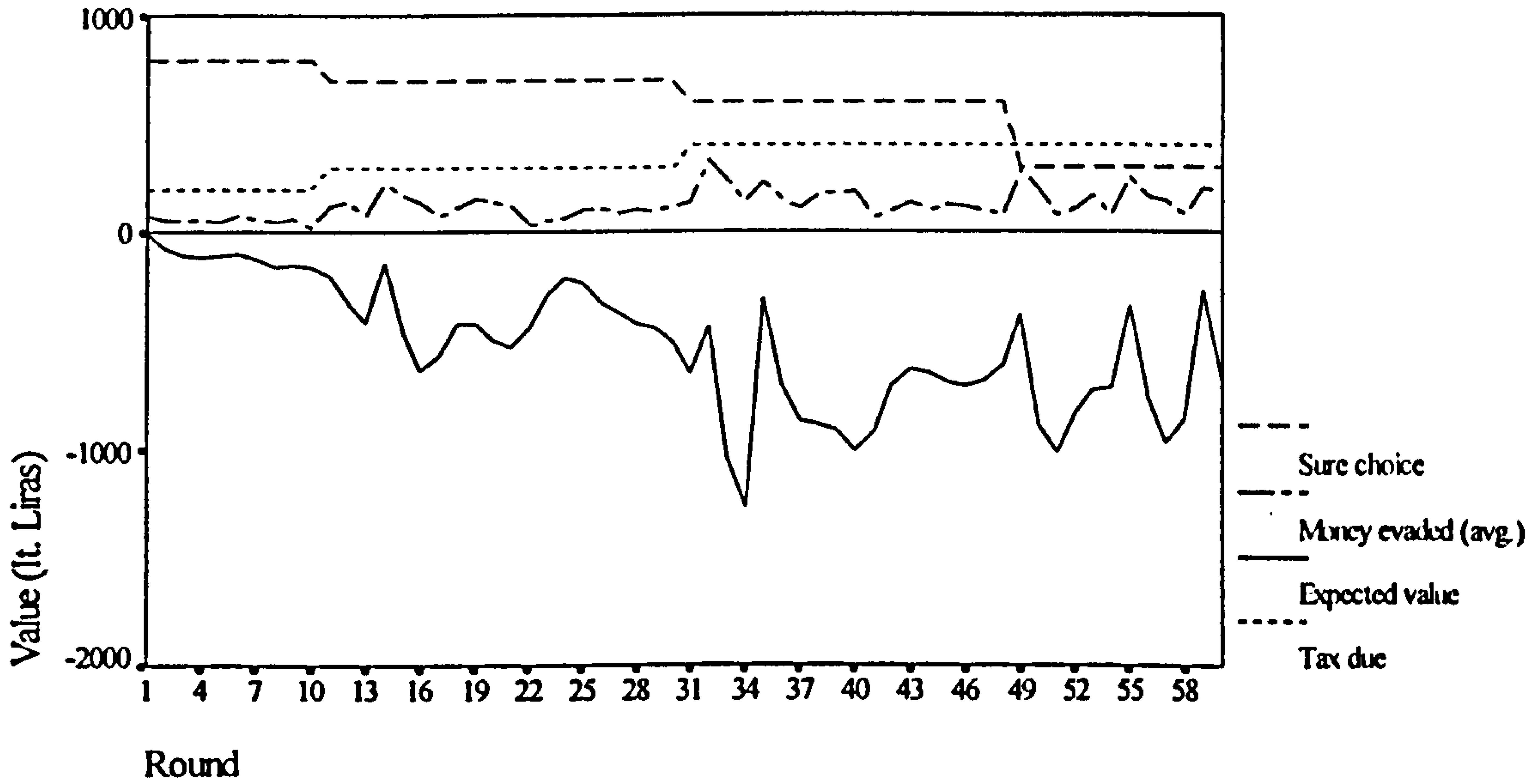
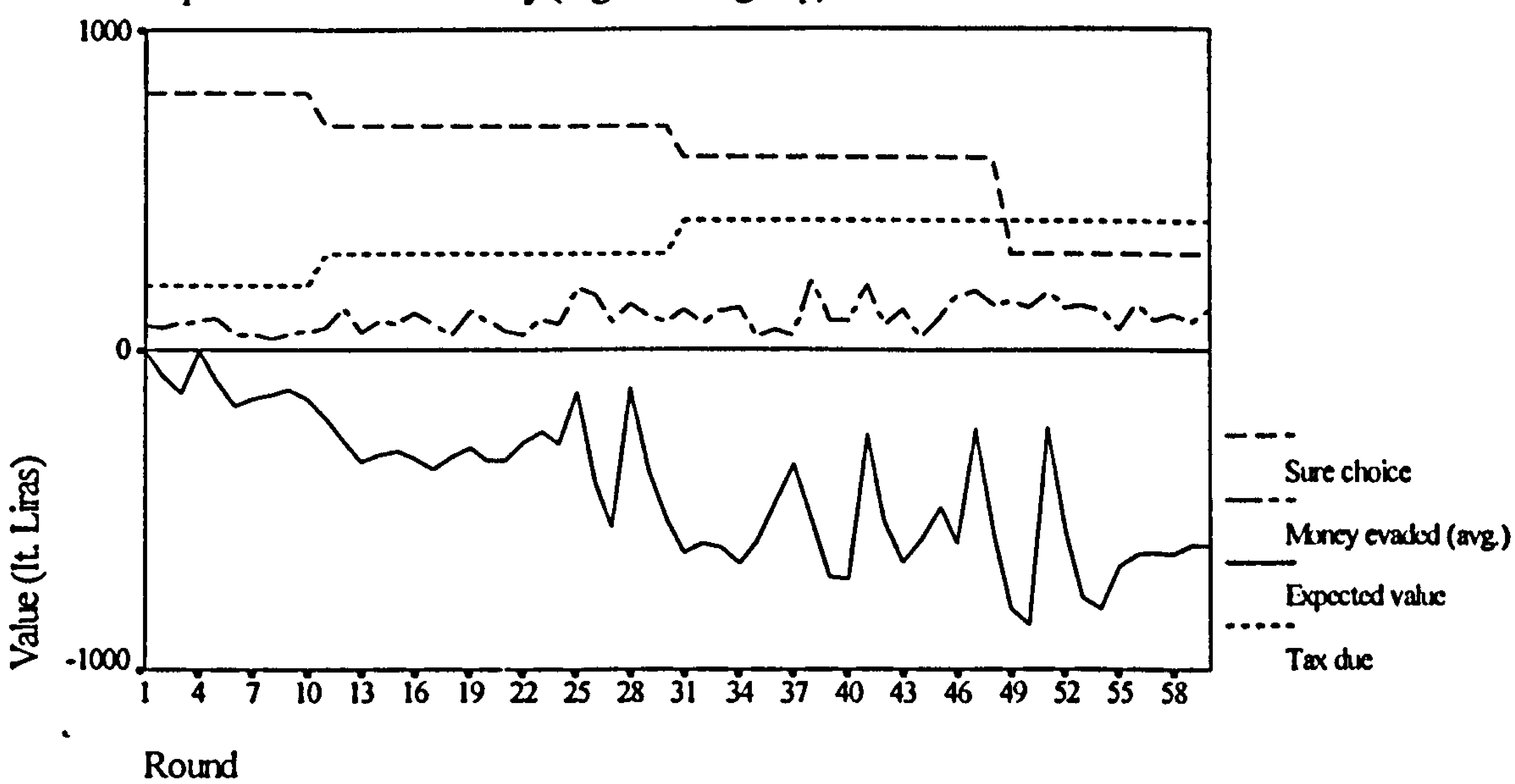


Fig. 5.5 Standard Exp. (DY1)

Expected values from lottery (avg. second group)



An even better picture of this phenomenon is given by table 5.2, which reports the average tax evaded per round and the extent to which subjects tend to increase their evasion when the sure choice decreases.

On the other hand, and this time in contrast with expected utility theory, the expected value from evasion is negatively correlated with the amount of tax evaded. The linear correlation coefficients computed for these variables are - 0.2735 for the first group of subjects (with a significance level of 0.03) and - 0.2097 for the second group (with a significance level of 0.1). I have just said that to justify the dynamics reported by figs. 5.2 and 5.3 from the expected utility theory perspective, we must assume that the subjects were choosing randomly. Now, explanation of the inverse correlation between tax evasion and expected value from evasion requires a different assumption: that is, we must hypothesise that the subjects' risk propensity changes with each round, and that it is negatively correlated with the expected value from evasion. I shall return to this topic after discussing the results from the other experiments.

Table 5.2 Sure choice and tax evaded (exp. DY1)

Round	Avg. tax evaded (It. Liras)		Sure choice (It. Liras)
	First sub-group	Second sub-group	
1-10	54.93	67.36	800
11-30	112.33	99.58	700
31-48	152.33	115.23	600
49-60	165.16	125.49	300

By combining the existence of an apparently rational behaviour, based on the inverse relationship between the sure choice value and the amount of tax evaded, with the continuously changing structure of the subjects choices, we may suppose that some form of adaptive dynamic behaviour is taking place. It seems that the subjects ignore the trend of the expected value from evasion (maybe because it is too difficult to compute) and that they 'explore' the space of their alternatives by changing their choices in each round. The situation is like that of someone doing a jigsaw puzzle who, when looking to the pieces of the puzzle on the table cannot combine them in her/his mind, and therefore decides to make numerous practical attempts to find the solution.

Returning to fig. 5.2 and 5.3 and introducing the graphs obtained from experiments DY2, DY3 and DY4 (fig. 5.6, 5.7, 5.8, 5.9, 5.10 and 5.11), one notes another important aspect of the results obtained from the experiments which may in some way support this latter consideration. Even if the trends are highly unstable and apparently follow some sort of random walk, one discerns a constancy in the rounds immediately after a fiscal audit, which is followed by a systematic increase in tax evasion. This increase generally has its lowest peak in correspondence to the round immediately after the fiscal audit, and sometimes lasts for more than one round. I shall call it the "bomb crater effect": the subjects choose to evade immediately after a fiscal audit because they think that it cannot happen twice in the same place (time). This effect may have some sort of echo, so that some subjects persist in evading for two or three rounds after the audit. It is important to stress that this echo effect is probably reduced (compressed in time) because of the particular system of fiscal audits introduced into the experiment, which took effect over the last three rounds before the active round (the round when the audit effectively took place).

The "bomb crater effect" is influenced neither by the tax yield redistribution nor by the context. Hence it can be assumed to be some sort of mental representation of probability activated by the subjects. One can test whether experiences modifies this mental representation of probability by looking at the behaviour of the subjects belonging to the separate sub-groups of each experiment. As just said, the subjects who participated in experiments DY1, DY2, DY3 and DY4 were all audited simultaneously during two rounds sequences, i.e. sequence 1: rounds 13, 31, 34, 48, 54, 58, and sequence 2: rounds 3, 24, 27, 40, 46, 50. The main difference between the two sequences concerns the moment in the experiment when the first audit takes place. In sequence 1, the first audit comes after a quite long period of game-playing (round 13) while in sequence 2 it occurs at the beginning of the experiment (round 3).

Table 5.3 shows the amount of money paid by the subjects belonging to the two subgroups of each experiment. One notes that being subjected to an audit at the beginning of the experiment produces a sort of risk aversion effect. The members of the first subgroups (sequence 1) always evade more, and consequently pay less, than the members of the second subgroups (sequence 2). The only and very interesting exception to this rule is experiment DY4 - that is, the experiment that was designed as a game and not as taking place in a real world context. I shall return to this important exception shortly, when I have discussed the point about learning to be risk adverse.

Table 5.3 Evaders and tax yields of the sub-groups

Experiment	Number of evaders	total tax yield (Italian liras)
DY1 first sub-group	502	187,201
DY1 second sub-group	449	206,318
DY2 first sub-group	275	236,782
DY2 second sub-group	224	258,563
DY3 first sub-group	436	217,763
DY3 second sub-group	279	249,258
DY4 first sub-group	502	197,561
DY4 second sub-group	510	199,963

Fig. 5.6 Exp. with redistribution (DY2)

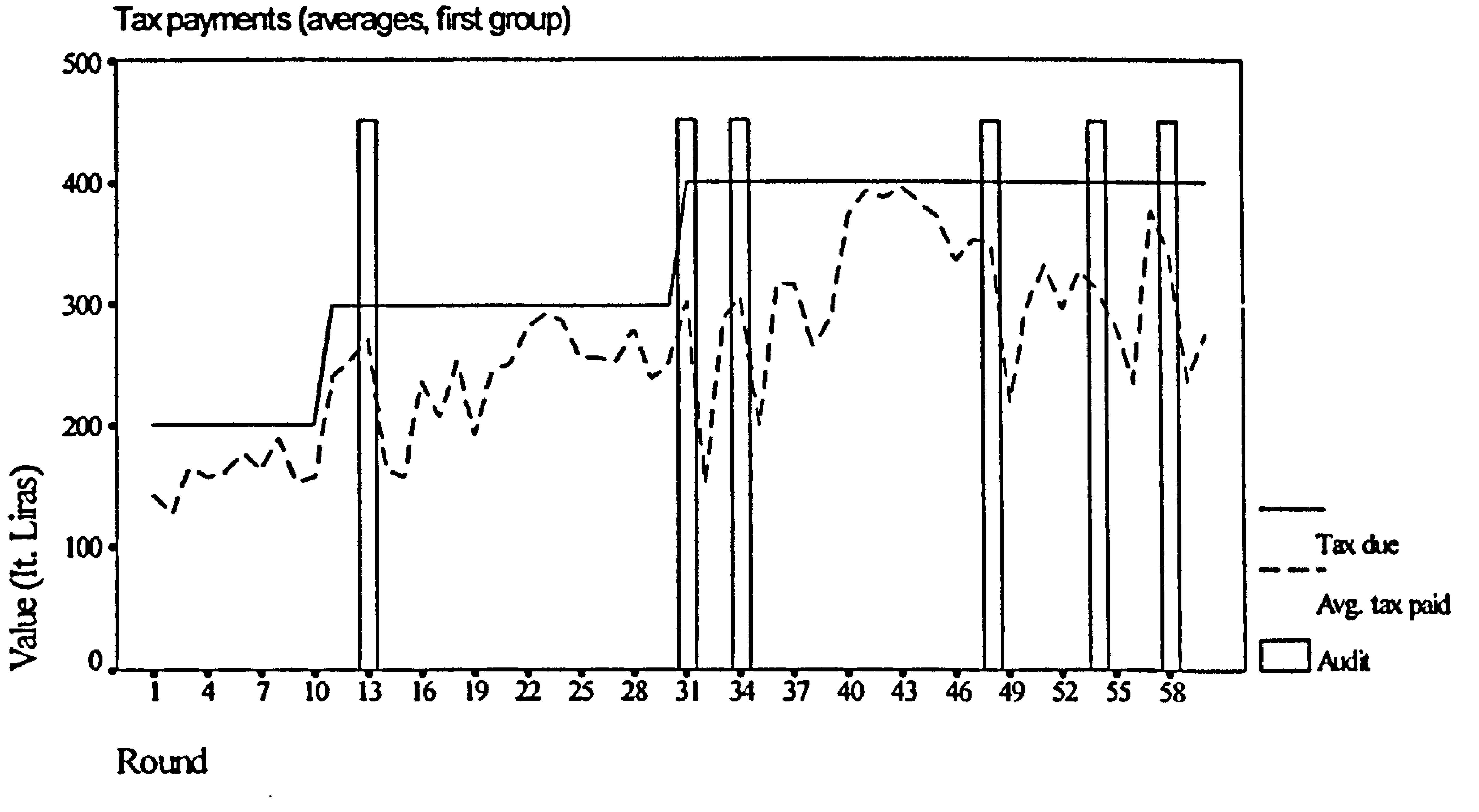


Fig. 5.7 Exp. with redistribution (DY2)

Tax payments (averages, second group)

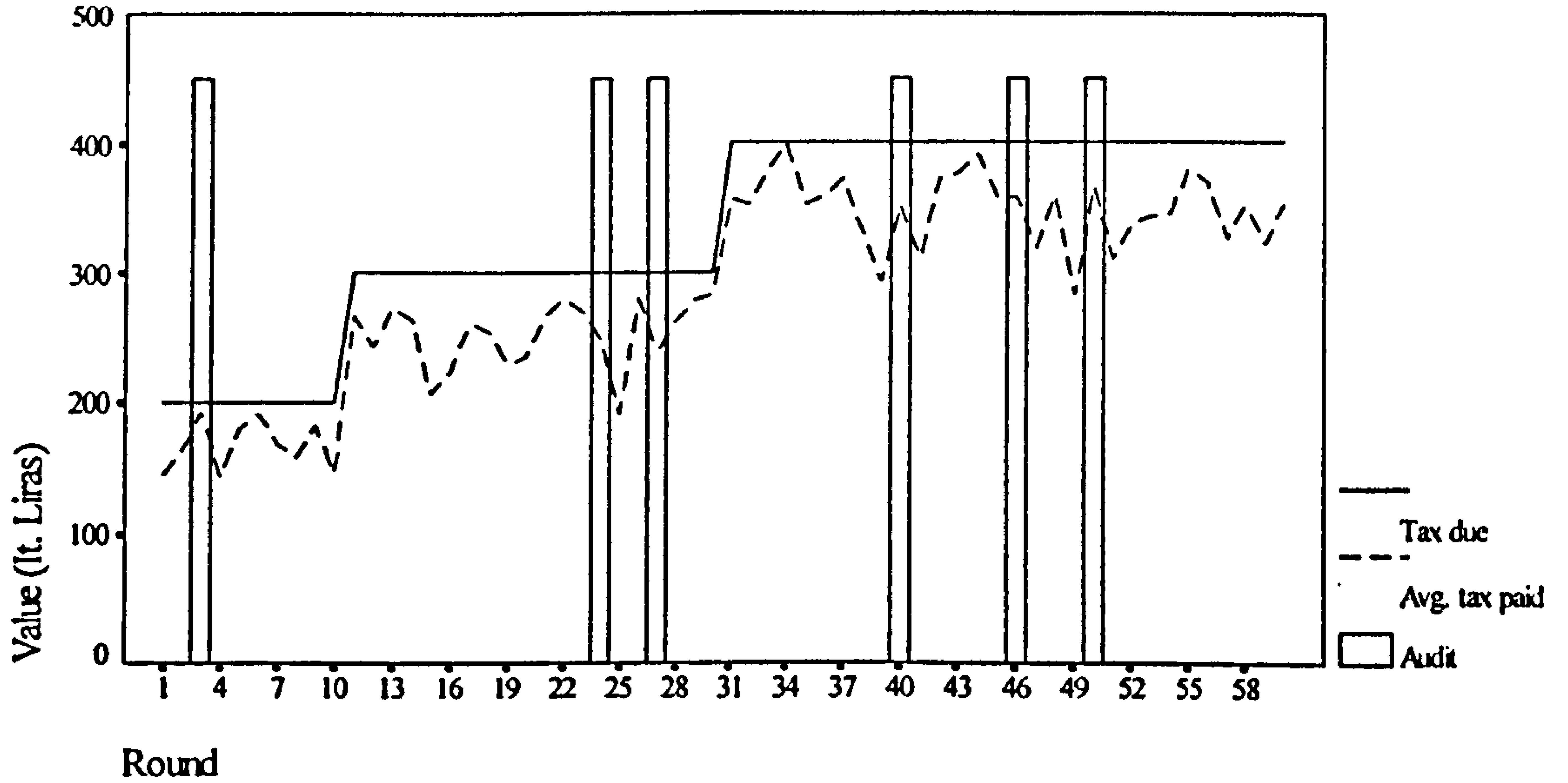


Fig. 5.8 Exp. with public good (DY3)

Tax payments (averages, first group)

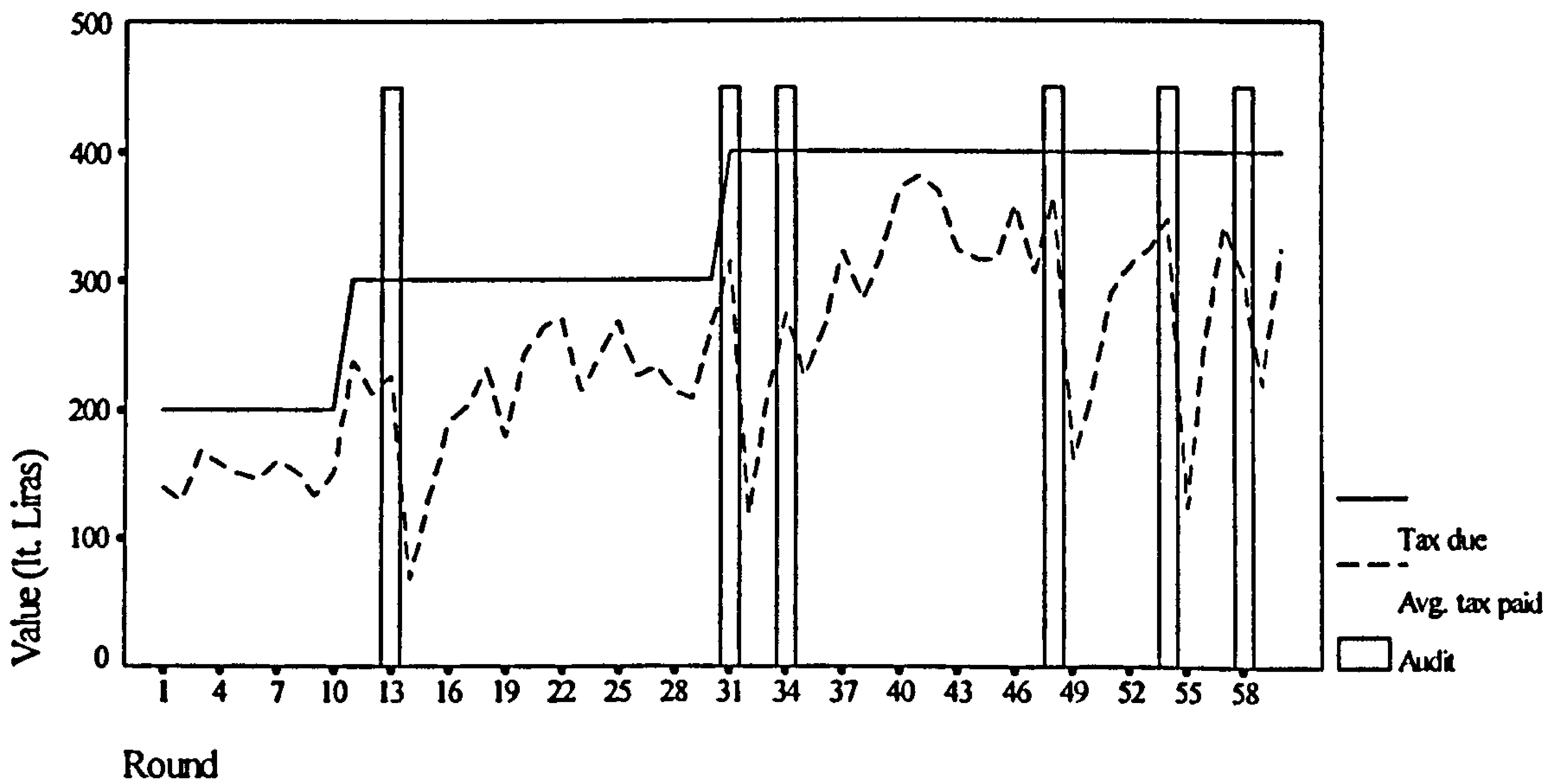


Fig. 5.9 Exp. with public good (DY3)

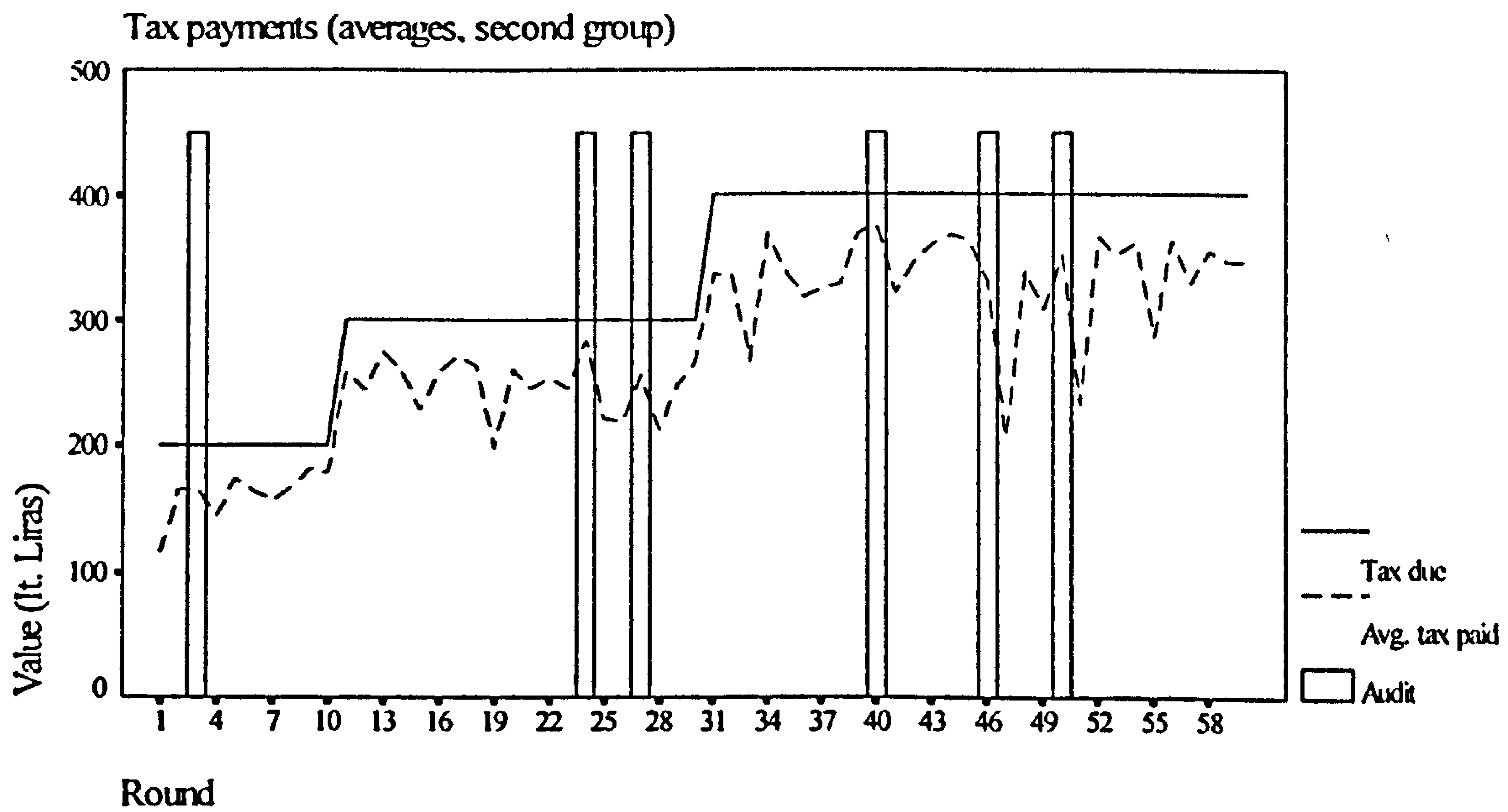


Fig. 5.10 Gamble experiment (DY4)

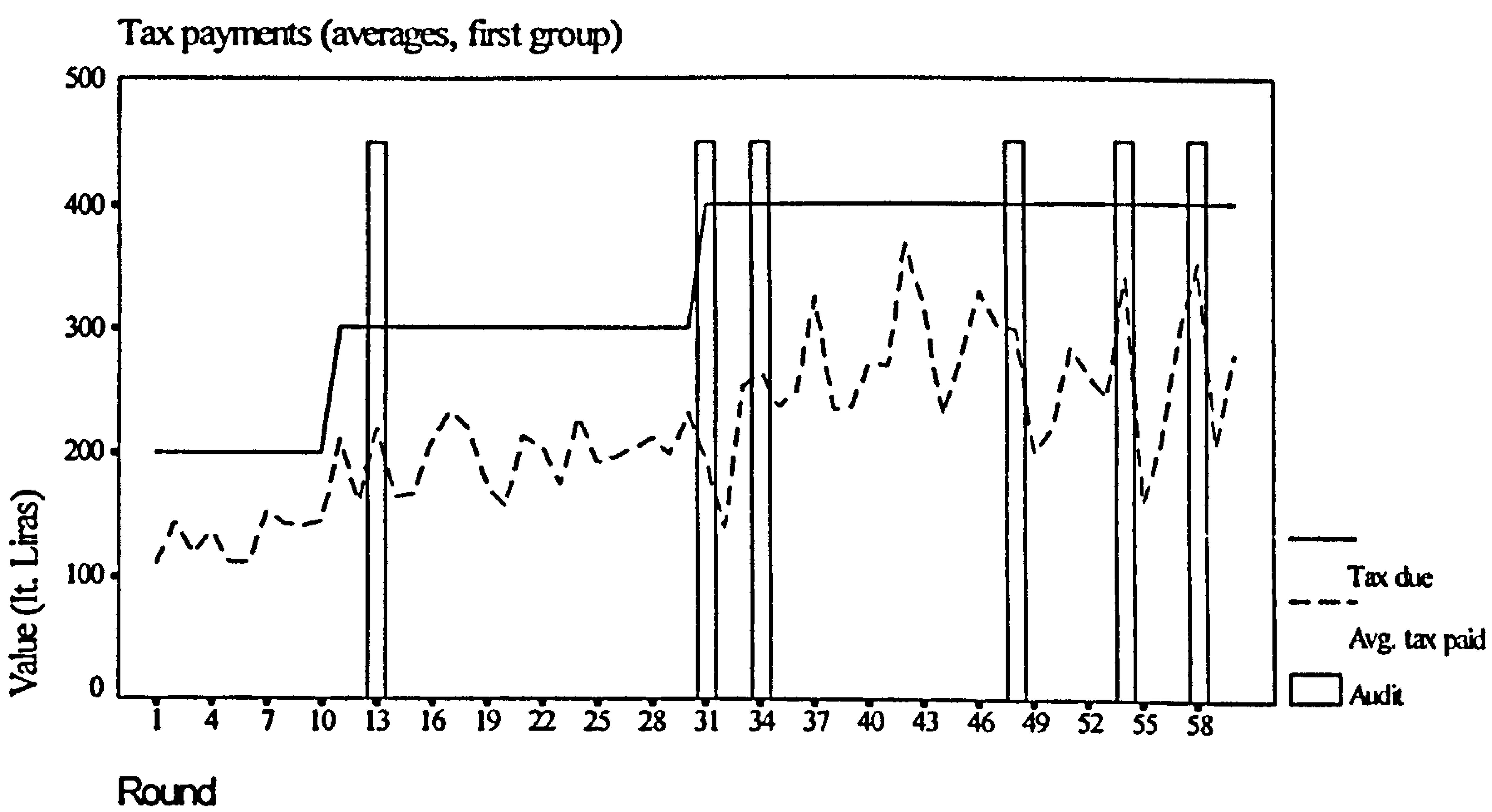
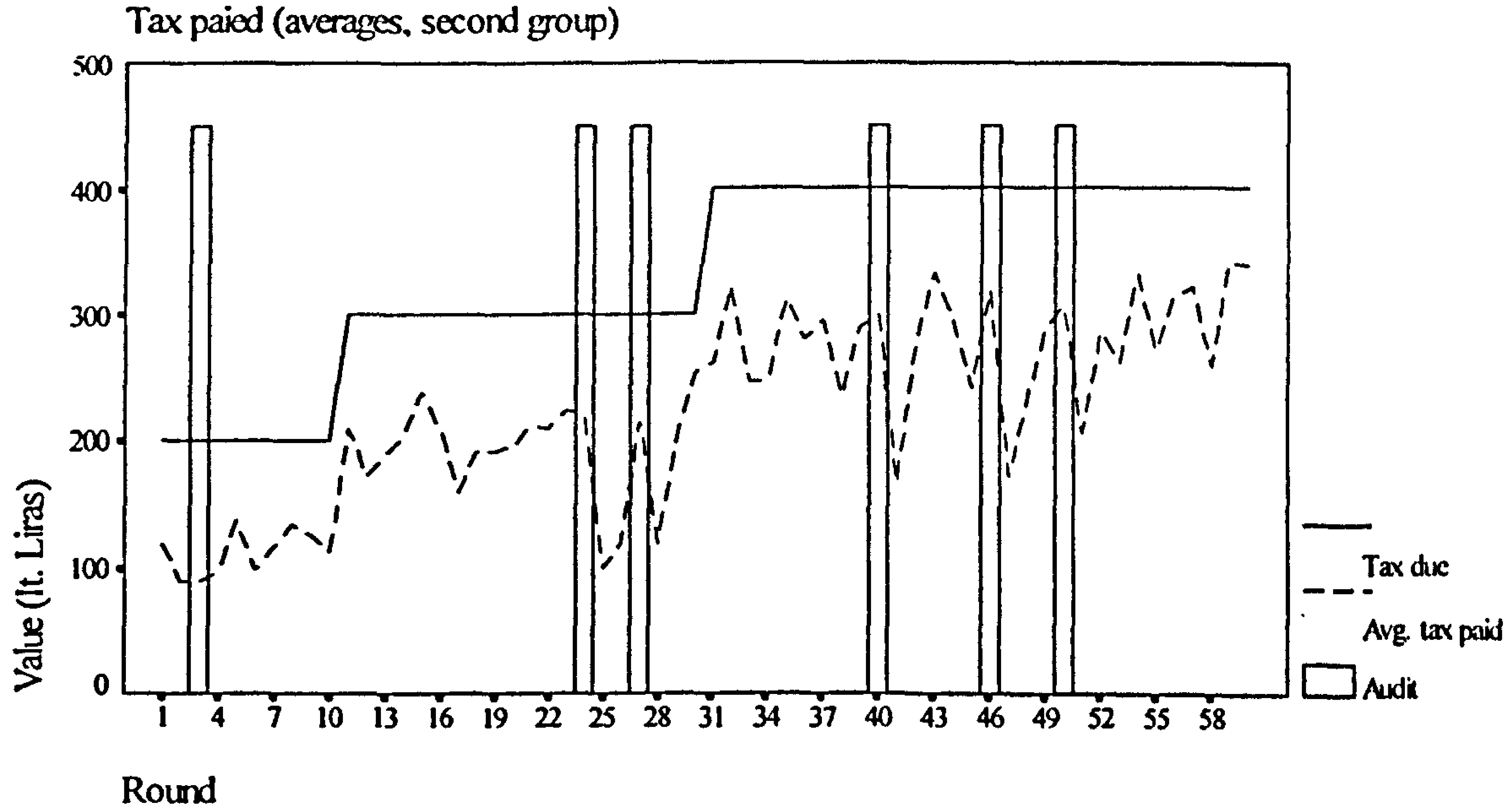


Fig. 5.11 Gamble experiment (DY4)



To investigate the apparent phenomenon of learning to be risk adverse requires the introduction of experiment DY5, the results of which are given in figs. 5.12 and 5.13.

Fig. 5.12 Special audits exp. (DY5)

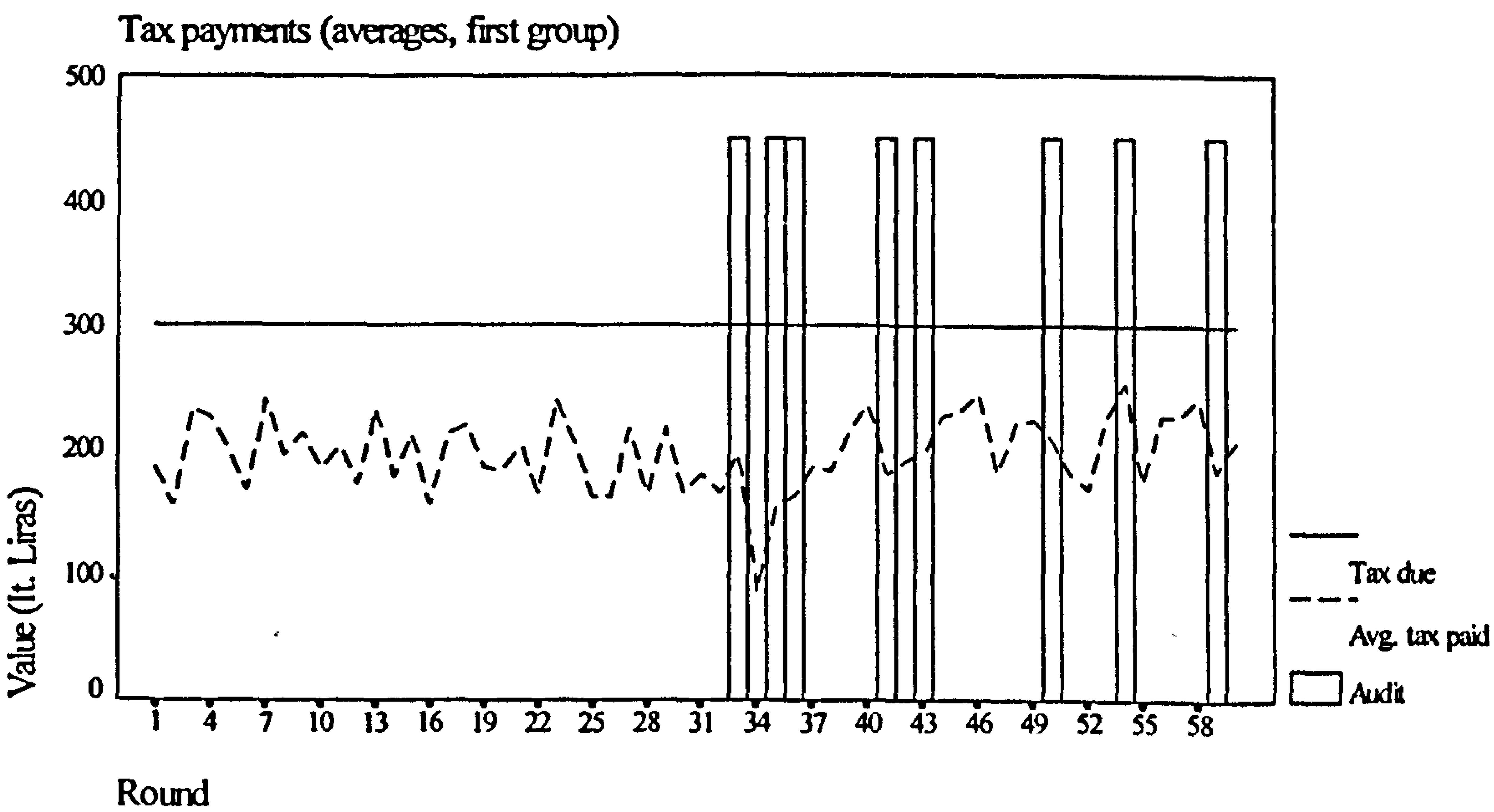
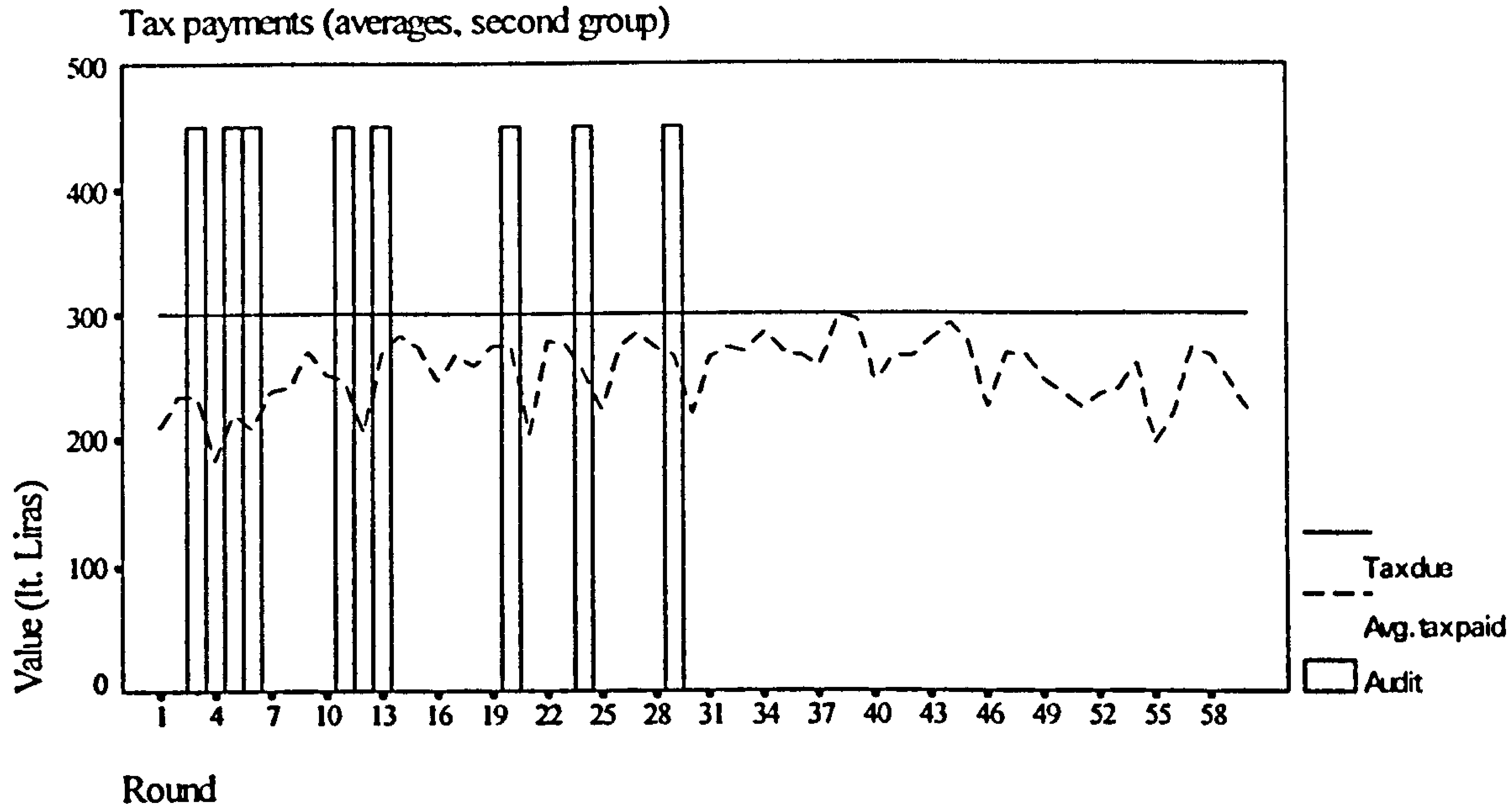


Fig. 5.13 Special audits exp. (DY5)



It is evident from figs. 5.12 and 5.13 that, in experiment DY5, the fiscal audits were concentrated in the second half of the experiment for the subjects belonging to the first group, and in the first half for the subjects belonging to the second group. The structure of the lottery in DY5 was kept constant for the entire experiment in order to isolate the effects produced only by the audit timing. The result is clear. The subjects who "learnt" in the first half of their experimental lives that fiscal audits are a very uncommon event became risk takers (the total tax yield for them was only 177,429 lire, while the total tax yield for the subjects belonging to the second sub-group was 227,831 lire). They had a strong propensity to evade taxes which persisted when they move into the second half of their experimental lives, when the probability of being audited increased dramatically. The tax yield of the first 30 rounds (88,104 lire) was only slightly lower than the tax yield for the following 30 rounds (89,325 lire). By contrast, the subjects in the second group learned that fiscal audits were very frequent and consequently also learned to be risk adverse, maintaining this virtuous behaviour for the entire experiment. These subjects paid 111,645 lire in the first 30 rounds and paradoxically even more (116,186 lire) in the second part of the experiment, when they were never investigated.

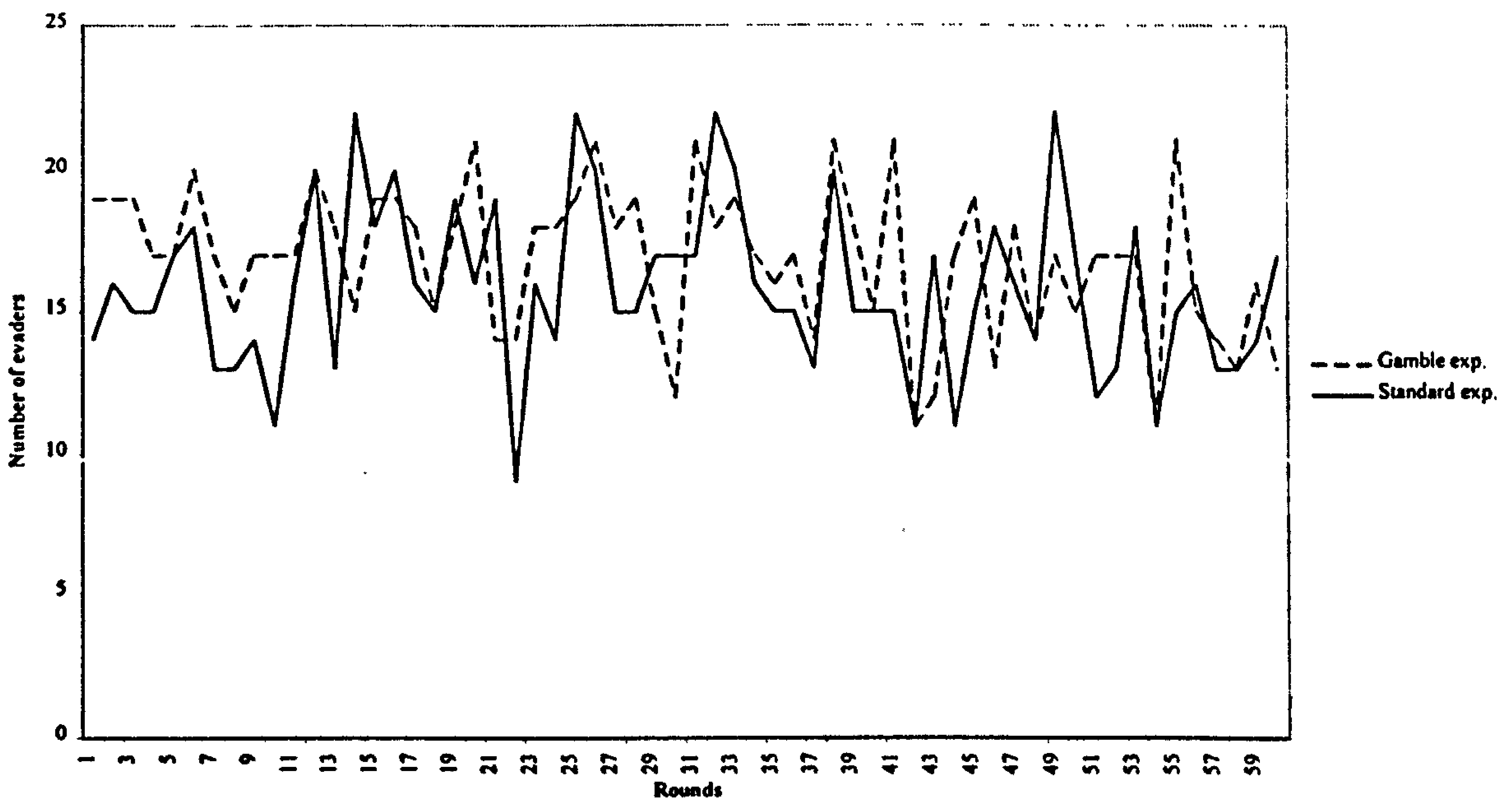
Table 5.4 Evaders and tax yield experiment DY5

Experiment		N° of evaders	Tax yield (It. Liras)	Avg. Evasion (It. Liras)
first sub-group	rounds 1-60	406	177,429	228
	rounds 1-30	221	88,104	212
	rounds 31-60	185	89,325	247
second sub-group	rounds 1-60	255	227,831	165
	rounds 1-30	146	111,645	160
	rounds 31-60	109	116,186	173

These results are reported in table 5.4, together with two other interesting items of information: the number of evaders (or, more precisely, the number of acts of tax evasion) and the average amount of money evaded in each tax evasion. One notes that the total number of evaders decreases for both the two sub-groups between the first 30 rounds and the second half of the experiment, while the average amount of taxes evaded increases. This phenomenon suggests that two main forms of adaptive behaviour were developed by the subjects in both the experiments: the subjects who decided to adopt the first strategic response tried to save money by reducing evasion - that is, they progressively abandoned evasion and adopted predominantly honest behaviour. Those subjects who adopted the second strategy tried to force their luck by evading larger and larger amounts of money as the experiment progressed. I shall return to this topic in the next section, which is devoted to analysis of individual behaviours.

I have pointed out that there was an exception to the rule that the members of the first subgroups always evaded more than the members the second subgroups. This exception was experiment DY4, where the subjects belonging to the two subgroups adopted almost identical behaviour, or more precisely, reversed the rule by evading more (510 evaders) in the first sub-group and less (502 evaders) in the second sub-group. This phenomenon introduces one of the topics that I treated with the dynamic experiments, namely the role played by the experimental context. The point is this: did the subjects really perceive the context that we tried to reproduce (i.e. a tax payer problem) or did they behave as if they were playing a video game? Furthermore, it should be borne in mind that this suspicion is reinforced by the fact that the dynamic experiments were carried out using computers. One way to investigate this issue is to compare the results obtained from the standard experiment with the results reported from the gamble experiment, because they were perfectly identical in the lottery structure. The results from both the experiments are plotted in fig. 5.14.

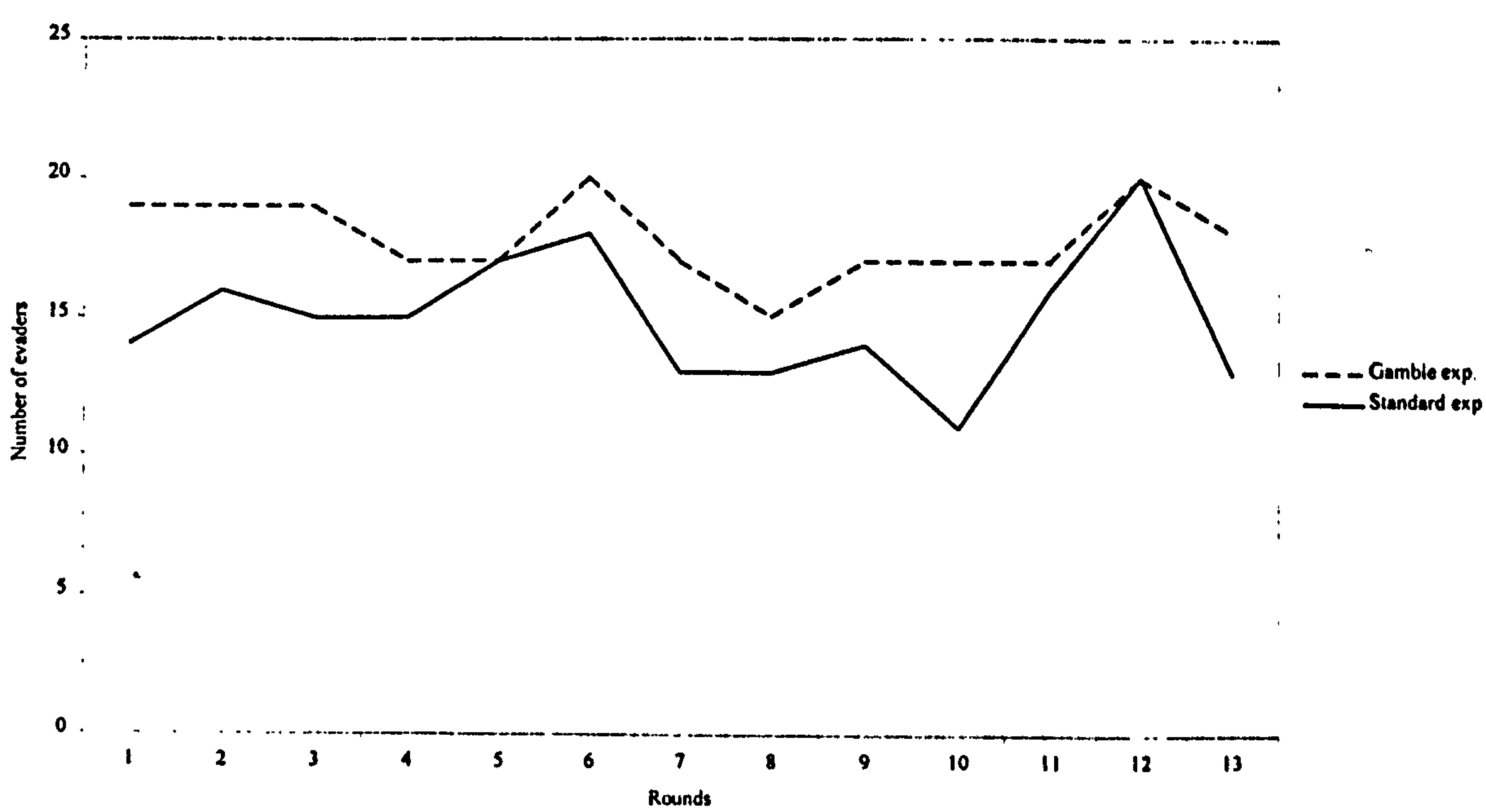
Fig. 5.14 Number of evaders standard exp. (DY1) and gamble (DY4)



From a first look of the plots shown in fig. 5.14, it might seem that the behaviours of the subjects of the two experiments are very similar, if not identical. Nonetheless, closer examination of the trends reveals that the behaviours are not always as similar as it might appear. In fact, if we look at the first 13 rounds we find that the number of evaders in the standard experiment is always lower (except for round 5 and round 12 where the number of evaders is the same for both experiments) than the number of evaders in the gamble experiment. This phenomenon can be evaluated better by looking at fig. 5.15 and fig. 5.16, which show the number of evaders respectively for the first 13 rounds and for rounds 14-31. The subjects that participated in the standard experiment paid about 10% less taxes in the first 13 rounds than those who participated in the gamble experiment (59,705 It. Liras versus 54,140 It. Liras). By contrast, in the following 18 rounds the two groups of participants paid almost the same amount of taxes (respectively 106,395 liras were paid by the subjects of the standard experiment and 106,584 by the subjects of the gamble experiment). It is worth stressing that carrying out a statistical test to check if the differences between the two sub-groups of rounds are statistically significant is vital, because the number of observations is small. Moreover, the parametric tests usually adopted to verify whether two samples belong to the same statistical population, like the t-test, requires satisfaction of the well known postulates about the normality of the distribution of the population from which the samples are extracted. One way to overcome these limitations is to use a non-parametric test, which gives results that are less robust if compared with those obtainable by using a parametric test but at the same time allows one to avoid the hypothesis on the distribution of the starting population. Furthermore the non-parametric tests can easily manage small samples.

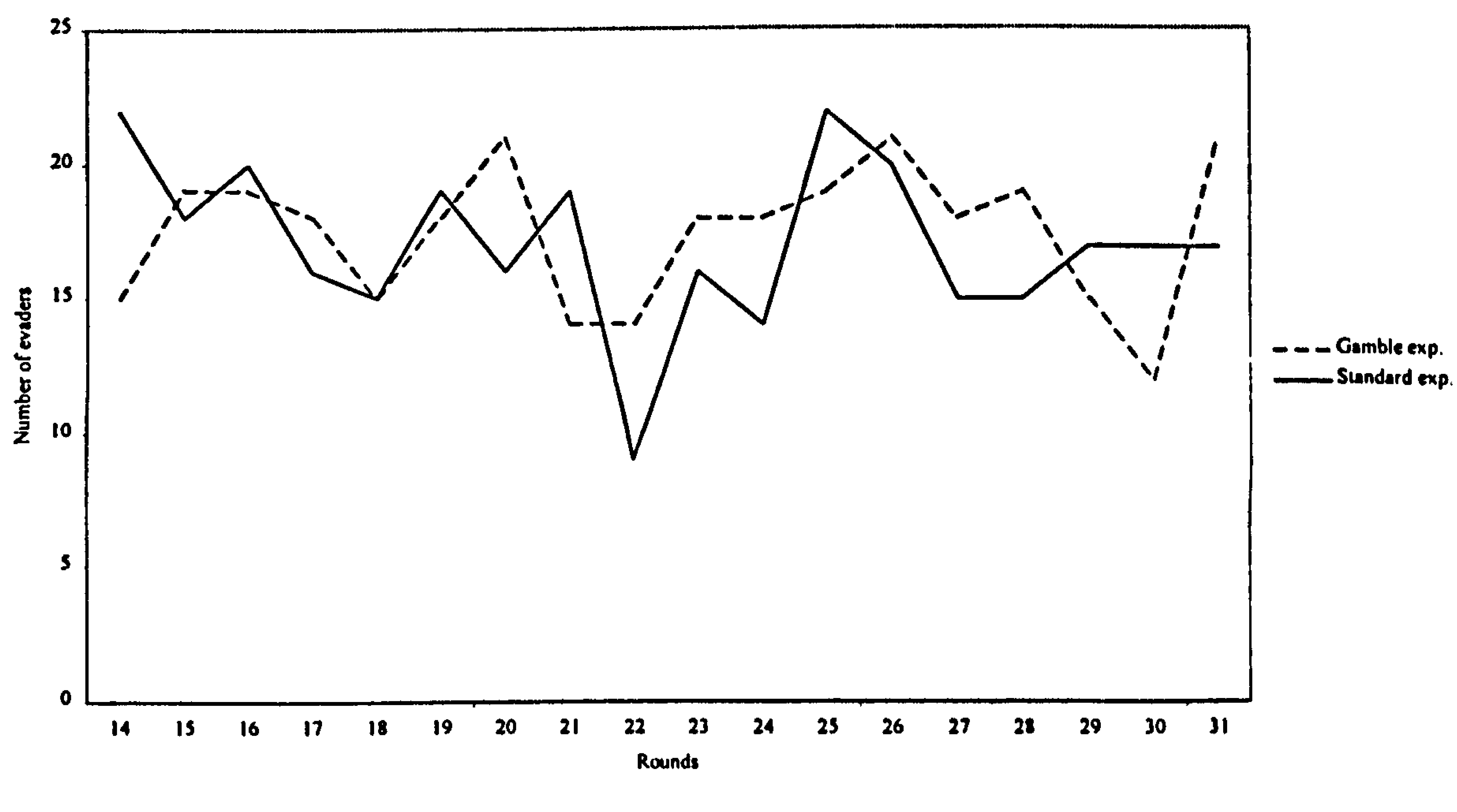
Running the Mann-Whitney (1947) test (also known as Wilcoxon-Mann-Whitney test) to verify whether the difference in the number of evaders in the first 13 rounds is statistically significant between the two groups of subjects, we can reject with a 0.002 level of significance the null hypothesis that the two samples come from populations with the same distributions.

Fig. 5.15 Number of evaders exp. DY1 and DY4 rounds 1-13



The data collected from the experiments do not give a sure answer to this phenomenon, but a reasonable explanation can be suggested by consideration of the role played by the fiscal audits (or by the corresponding "drawing" of the gamble experiment). After the first 13 rounds, all the subjects in both the sub-groups of each experiment experienced one inspection (or drawing). The first two sub-groups at round 13 and the second sub-groups at round 3. The interesting point is that the effect played by this experience seemed to modify the risk attitude only of the participants in the gamble experiment. In other words, it seems that at the beginning of the experiment the subjects of the gamble experiment were more risk-takers than the subjects of the standard experiment, but this attitude changed after they experienced the first fiscal inspection, and became almost identically distributed among the participants in both experiments. This change in the risk attitude of the participants in the gamble experiment suggests that there is some form of relationship between the different experimental contexts and the attitude towards risk. At the same time, the risk attitude seemed to be influenced in accordance with the experimental context, by the experience of being extracted for audit.

Fig. 5.16 Number of evaders exp. DY1 and DY4 rounds 14-31

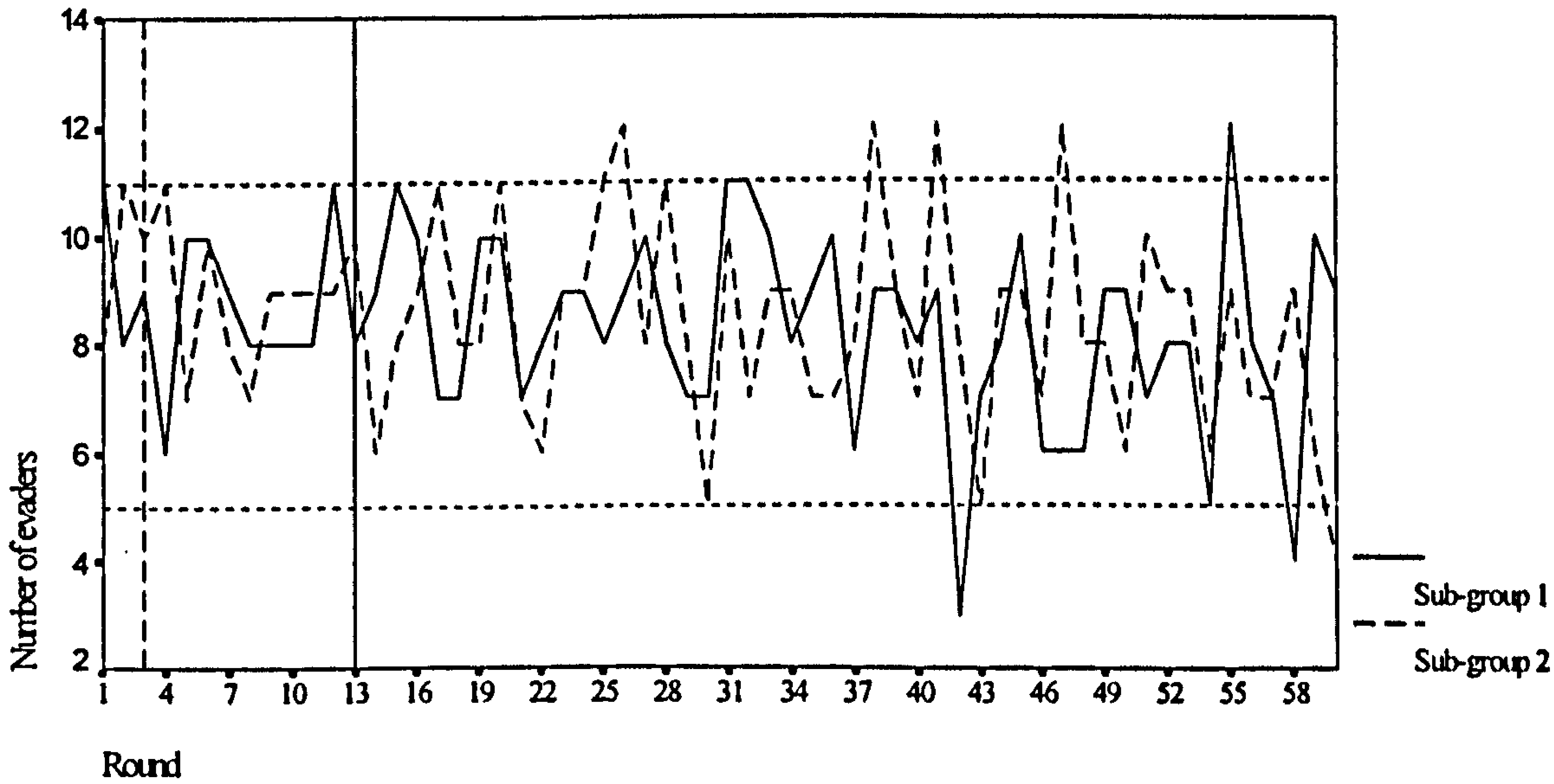


This phenomenon is confirmed by looking at figs. 5.17 and 5.18, which show the trends in the number of evaders for the two sub-groups in the standard experiment and the gamble experiment. In the standard experiment, as well as in all the other tax evasion experiments, the different timing of the audit experience produced a different behavioural pattern within the sub-groups .of each experiment. In the tax evasion experiments, as will be seen shortly, those who experienced an audit within the first rounds tended to evade less frequently (and to a lesser amount) than those who were inspected later. By contrast, in the gamble experiment the subjects who evaded more frequently were those who belonged to the sub-group that was drawn in the first part of the experiment.

In figs. 5.17 and 5.18, I fixed an arbitrary "high" number of evaders corresponding to 11 evaders per each round and a similarly arbitrary "low" number of evaders equal to 5 evaders. By counting the number of rounds with a number of evaders equal to or higher than 11 and, symmetrically, the number of rounds with a number of evaders equal to or lower than 5, one sees that the behaviours of the two sub-groups in the two experiments are mirror-reversed.

Fig. 5.17 Number of evaders exp. DY4

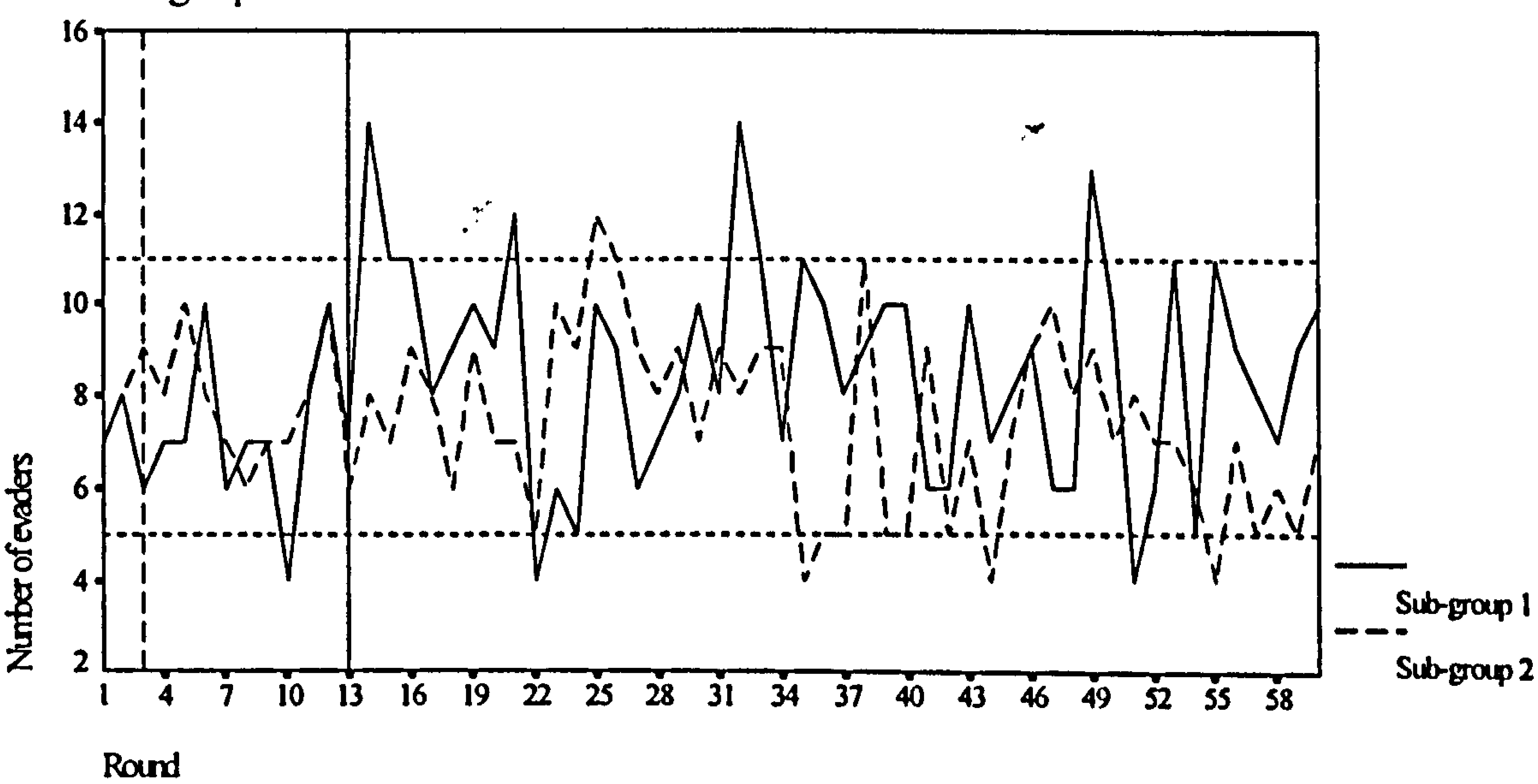
Sub-groups 1 and 2



In the gamble experiment (fig. 5.17) those who experienced the first draw at round 13 (sub-group 1) reached or exceeded the "high" arbitrary line only 4 times, while those who were drawn for the first time at round 3 (sub-group 2) reached or exceeded the high line 10 times. By contrast, in the standard experiment the subjects belonging to the first sub-group reached or exceeded the "high" line in 9 rounds, versus only 2 rounds for those in the second sub-group. Symmetrically, and always with regard to the results from the standard experiment, one also sees that the "low" number of evaders line is more frequently reached or went down by the sub-group 2 (11 times) than by the sub-group 1 (4 times). Conversely, in the gamble experiment the two sub-groups reached or went down the "low" line the same number of times (3 times). The learning process that built the individual attitude towards risk was therefore apparently influenced by the experimental context quite markedly, and at the same time yields further evidence on the different roles played respectively by the tax evasion frame and by the pure gamble design.

Fig. 5.18 Number of evaders exp. DY1

Sub-groups 1 and 2



These considerations highlight another interesting point concerning the nature of the relationship that ties the risk attitude to the subjective representation of probability. In all the dynamic experiments the probability of being audited was a known datum, and it should therefore be taken as "objective" information (and this is also the reason why it is correct to talk of taking decisions under conditions of "risk", instead of uncertainty). However, it is not possible to exclude the hypothesis that the experimental subjects do not treat this data within the "correct" computational frame. The well known probabilistic paradoxes discovered by quite simple experiments (most notably the St. Petersburg paradox discovered by Bernoulli, the Allais paradox and the Ellsberg paradox), demonstrate that even when all the probabilistic properties of a decisional problem are perfectly known the subjects can make "errors".

Particularly interesting as regards the experiments discussed here is the lesson from the Allais paradox, which can be condensed in the following statement: human beings tend to over-estimate the weight of small probabilities, making mistakes in the computation of the expected value of a given lottery and behaving in an apparently irrational way or, put more precisely, violating the substitution axiom. A simple description of the substitution axiom is suggested by Kreps (1990, p. 75). "Suppose that p and q are two probability distributions such that p is preferred to q ($p \succ q$). Suppose that α is a number from the open interval (0.1) and r is some other probability distribution. Then $\alpha p + (1 - \alpha)r \succ \alpha q + (1 - \alpha)r$." In the experiments analysed here, and more generally in all experiments that obtain results similar to those of the Allais paradox, it seems that p and/or q are not taken by the subjects to be given distributions, but are "re-modelled" as subjective probability distributions. Furthermore, in the experiments discussed here it seems that the modelling of these subjective probability distributions is in some way influenced by the decisional frame, i.e. they are functions of some context variables. It follows that if the values of the context variables change, then p or q changes, or both them.

Note that this latter consideration goes into a different direction from that taken by the above hypothesis that the learning process leads to becoming risk averse or risk taker, because it states that the lesson learnt by the subjects during the experiments has nothing to do with their disposition towards risk, which can be assumed to be a sort of "built-in" attitude, but it concerns their subjective representation of the probability of being audited. This representation can be imagined as a model (of functional form which cannot be easily deduced from the data) whose independent variables include the experience of being audited and the experimental context.

The main conclusions reached by analysing the aggregate data are summarised in table5.5.

Table 5.5 shows that the most robust results concern the effect of tax yield redistribution and of audits (what I have called "bomb crater effect"). Both these effects can be seen, from a normative perspective, as devices to reduce evasion. Obviously, this conclusion requires further analysis.

Table 5.5 Summary of the aggregate results from the repeated choices experiments

Experiment	Risk attitude	Psychological effects
DY1 objective probability; unfair lottery	1) higher number of evaders than the one-shot experiments 2) complex dynamic of choices 3) "bomb crater effect"	1) Correlation between the sure choice value and evasion 2) None correlation between expected value and evasion
DY2 objective probability; unfair lottery; tax yield redistribution	1) complex dynamic of choices 2) "bomb crater effect"	3) tax yield redistribution reduces evasion
DY3 objective probability; unfair lottery; public good	1) complex dynamic of choices 2) "bomb crater effect"	the production of a public good reduces evasion but less than redistribution
DY4 "gamble" experiment	1) complex dynamic of choices 2) "bomb crater effect"	1) the gamble context increases the risk attitude 2) the learning process is different if compared with the learning process carried out in the tax evasion context
DY5 objective probability; unfair lottery; artificial audits	1) complex dynamic of choices 2) "bomb crater effect"	3) learning to be risk adverse

5.3 The individual data

The conclusions reached in the previous section signal the utility of investigating the individual data. Analysing individual records is a rather complex undertaking, mainly because a relatively large number of observations are involved (30 subjects for each of the 5 experiments multiplied by 60 rounds each gives a total of 9000 values for each variable considered by the experiment) and because the individual behaviours displayed marked variability. A first step in organising the data set is to build some sort of behaviour taxonomy. One may begin by analysing the individual graphs, looking at two main characteristics: the percentage of tax paid in each round and the frequency of evasion. The aim is to find one or more general rules of behaviour.

Figs. 5.19, 5.20, 5.21 and 5.22 show the individual trends in the tax payments by four subjects taken from the standard experiment (DY1) who can be assumed to be representative of four different "styles" of play.

The first kind of behaviour can be called "absolute stability" and it is displayed by subject no. 28 (fig. 5.19), who always paid all the tax required. In the standard experiment only one subject decided to adopt this strategy, while in the experiment with tax yield redistribution (experiment DY2) 7 subjects decided to always pay the whole amount of tax due, which can be seen as further confirmation of the deterrent effect of tax yield redistribution. The second kind of behaviour is exemplified by the graph of subject no. 18 (fig. 5.20). It can be called "relative stability" because this subject always evaded but followed a variable path, i.e. s/he changed the amount of money evaded in every round.

Fig. 5.19 Tax Payments subject 28
Standard experiment (DY1)

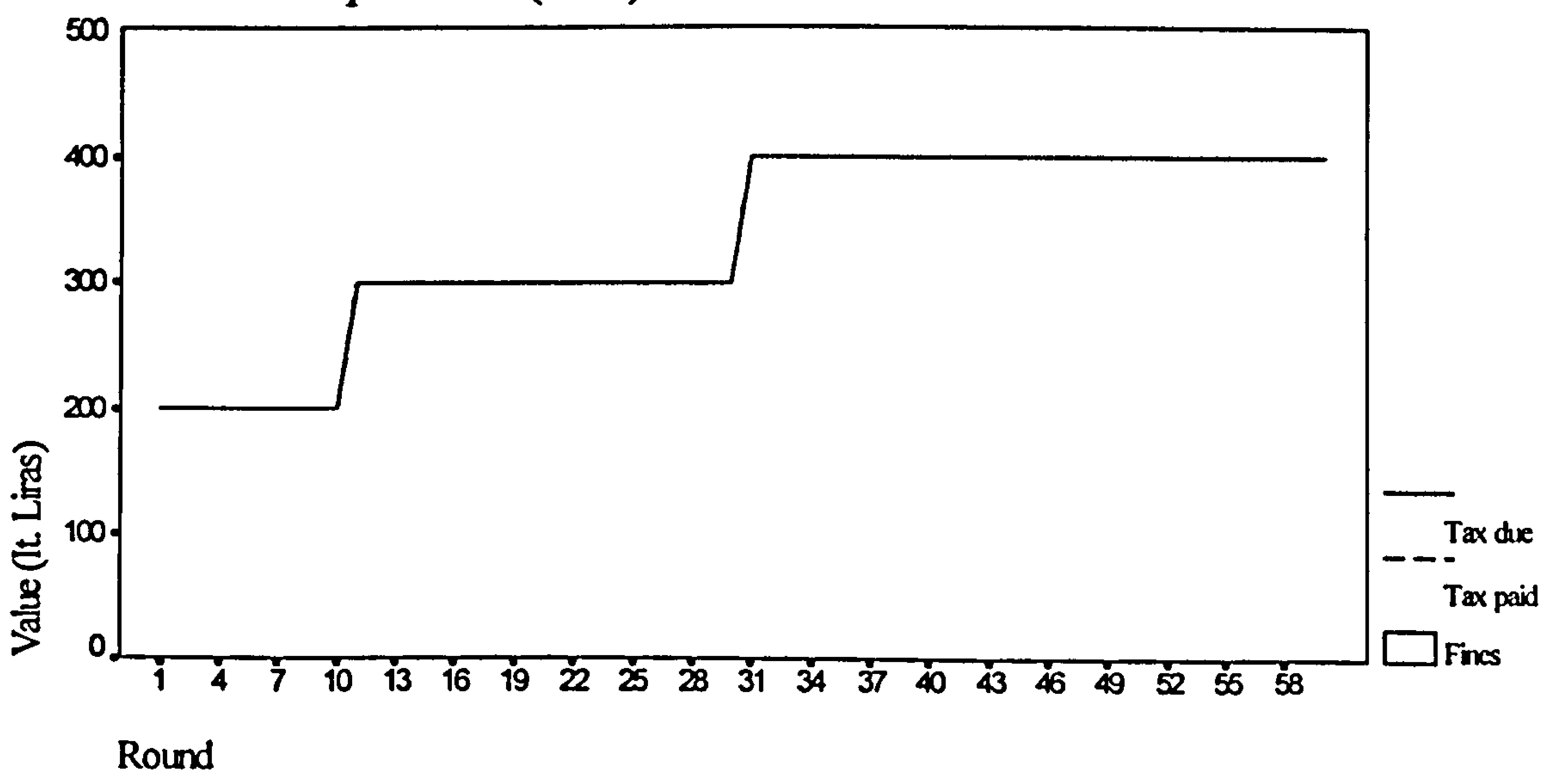
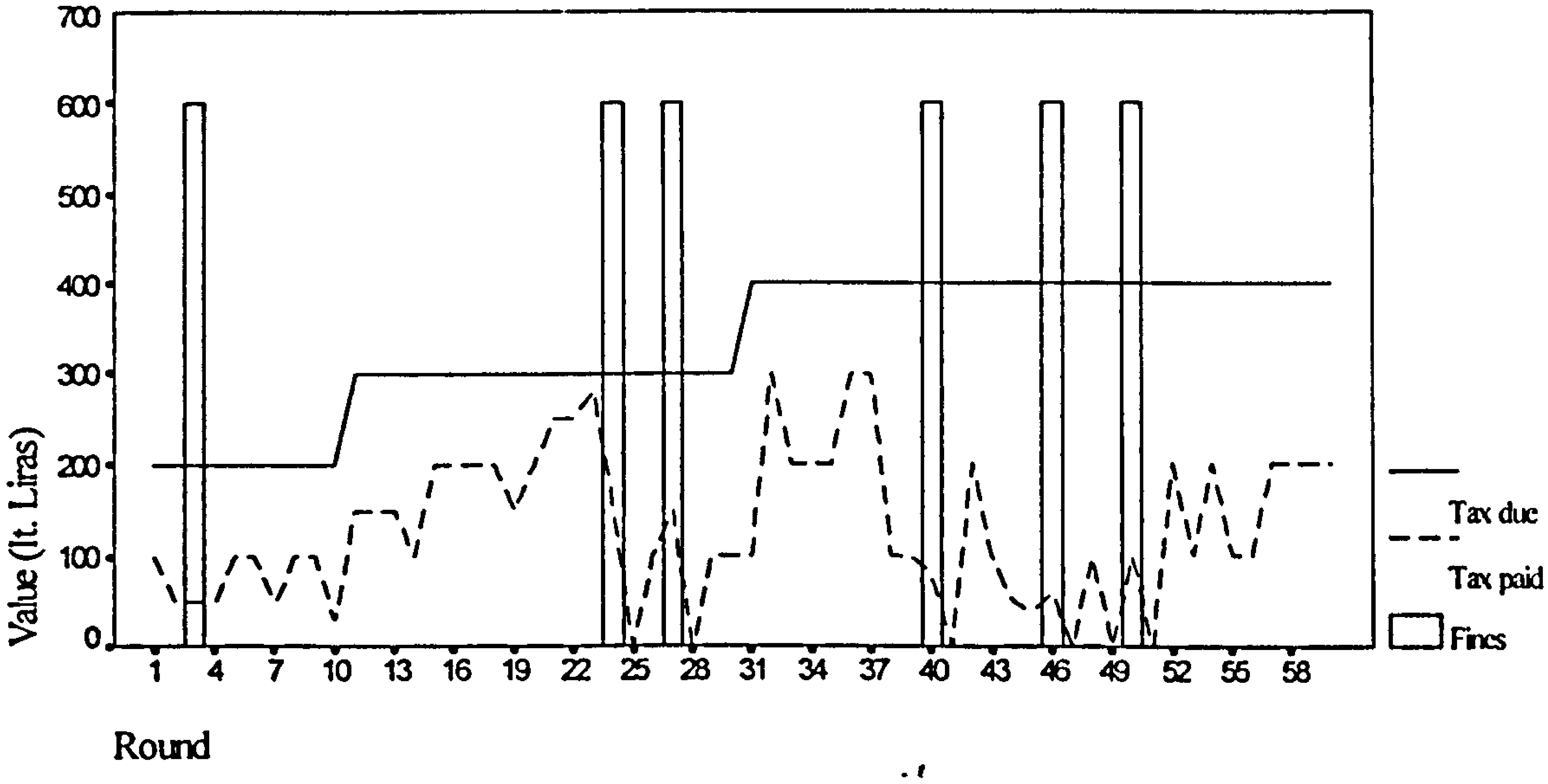


Fig. 5.20 Tax payments subject 18
Standard experiment (DY1)



Subjects 28 and 18 can be considered to belong to the same behavioural group, even though they decided on opposite strategies, because they show the same constancy in their attitude towards risk throughout the whole duration of the experiment. In fact, subject 28 is always risk averse (or risk neutral) while subject 18 is always a risk taker. The characteristic that prevents from placing them in a single behavioural group is the "oscillatory" dynamic shown by subject 18, who changes the percentage of tax paid in each round, which is exactly the opposite of the absolute constancy shown by subject 28, who never changes the percentage of tax paid (always 100%).

Fig. 5.21 Tax payments subject 0
Standard experiment (DY1)

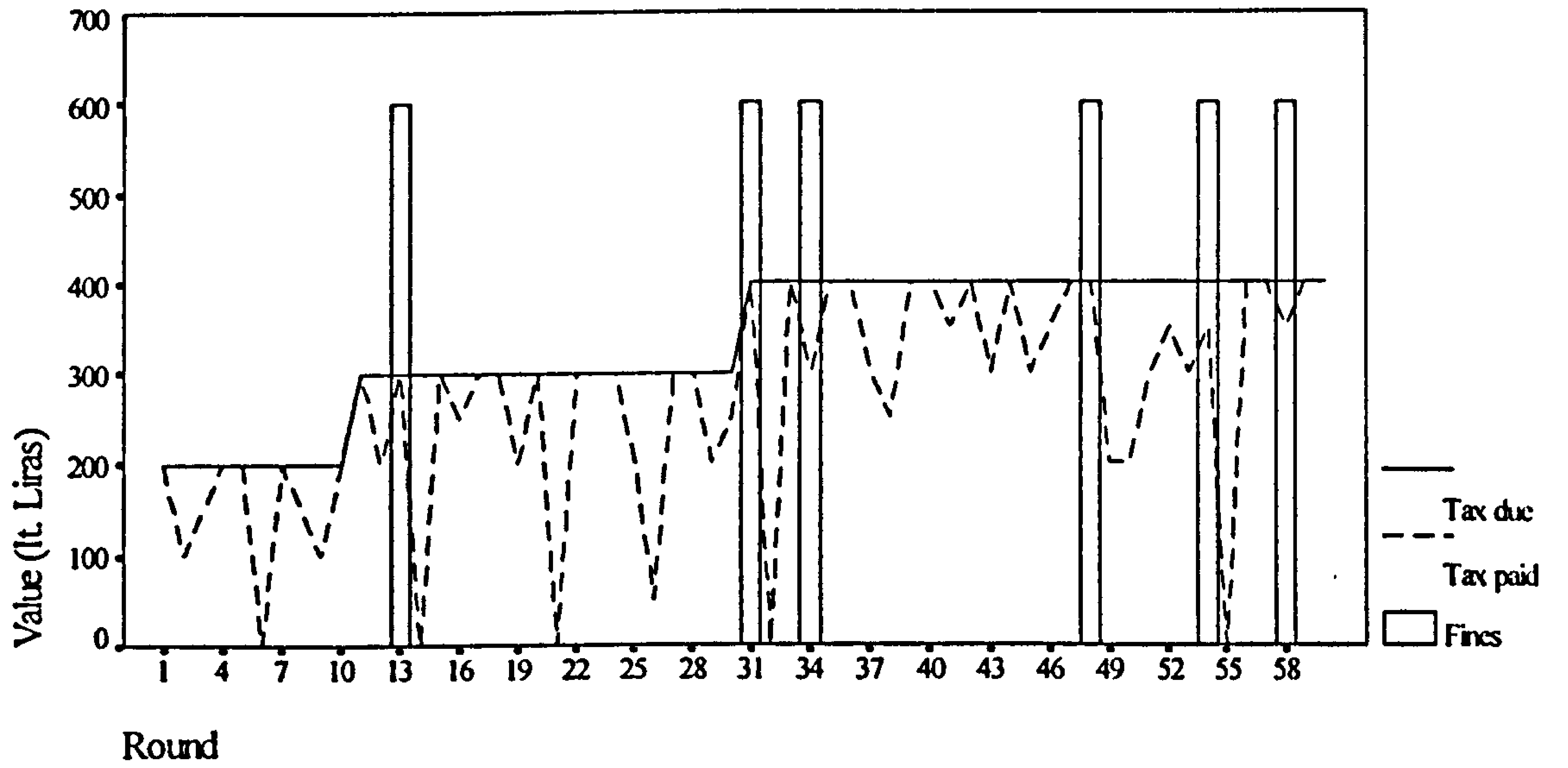
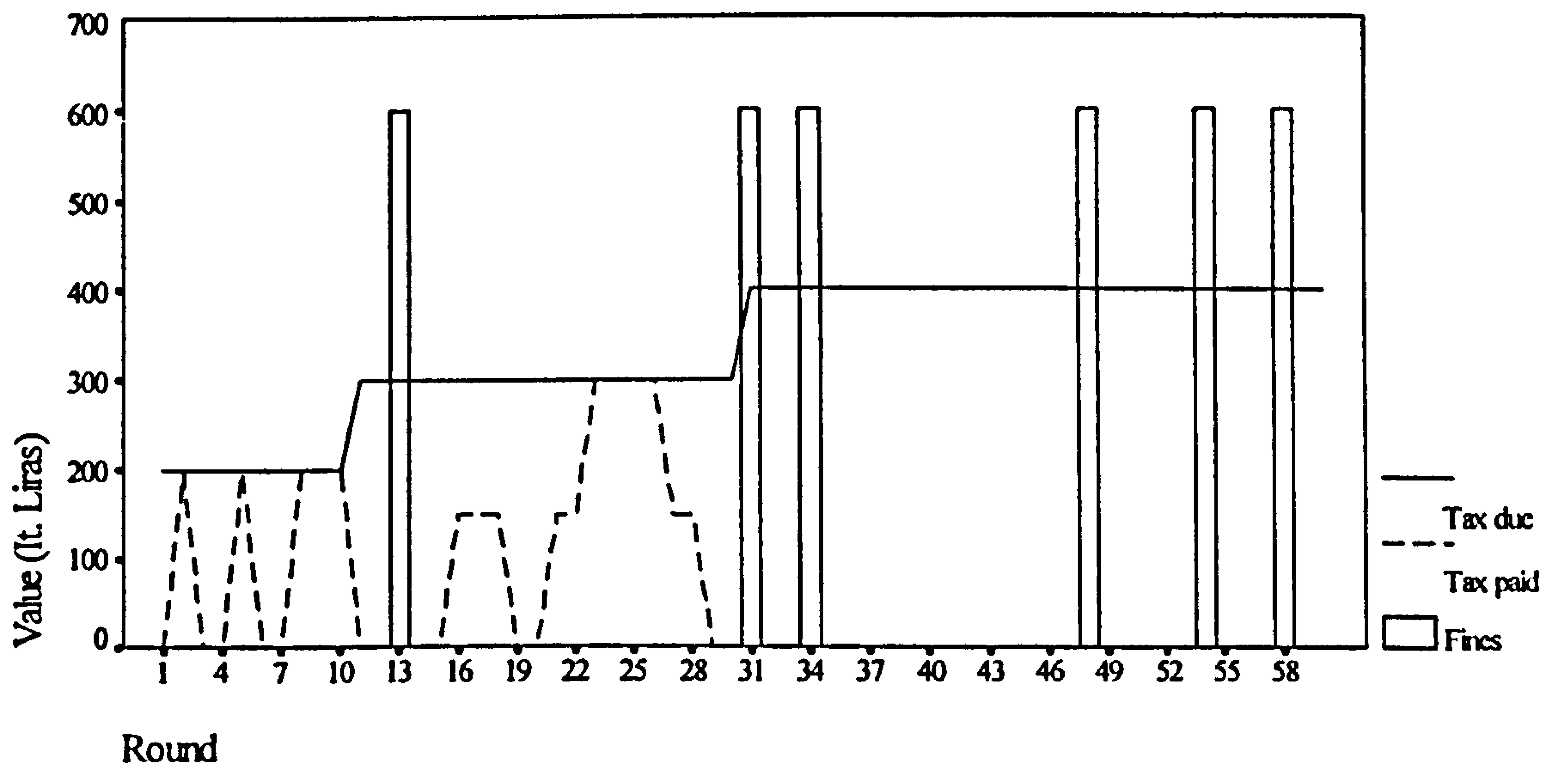


Fig. 5.22 Tax payments subject 8
Standard experiment (DY1)



The oscillatory trend of the choices of subject 18 is similar to that followed by all the other subjects who took part in the standard experiment. It is exemplified by the graph for subject 0 (fig. 5.21). Subject 0 followed some sort of random walk dynamic, combined with a continuously changing attitude towards risk, whereby s/he oscillated between total payment and partial (or sometimes total) evasion, with a ratio that comes very close to a perfect 1 to 1. This behaviour, which can be called "pendulum-like" (or, in other words, "once I pay once I evade") is unusual in its regularity (the almost perfect 1 to 1 ratio between evasion and payment) but it is very common with respect to the variability of the risk attitude.

Finally, the fourth behaviour is represented by subject 8 (fig. 5.22). This can be called "mixed" because in the first part of his/her experimental life this subject adopted a strategy in some way similar to that chosen by subject 0 (a sort of "pendulum" strategy but with a longer interval of oscillation and a different ratio between total payment and evasion, something like: I pay, I evade, I evade, I evade, I pay), while in the second part of his/her experimental life s/he decided to always evade the whole amount of tax due. This definitive change in the attitude towards risk, developed during the experiment, was evident in no other example in any other experiment, so that subject 8 is the only case that shows this behaviour.

The simple taxonomy described by using the four graphs of figs. 5.19, 5.20, 5.21 and 5.22 cannot be assumed to be satisfactory, because it does not provide an unambiguous criterion with which to group the subjects into statistically robust categories. The only unambiguous group that can be built is the one represented by subject 28. Unluckily, however, this kind of behaviour (always pay the entire amount of tax due) is uncommon (only 1 subject in experiment DY1, 7 subjects in experiment DY2, 2 subjects in experiment DY3 and no subject in the gamble experiment DY4). It can therefore be assumed only as some sort of very particular behavioural category. Similarly, also the strategy adopted by subject 18 (always evade) can be be assumed to be an extreme behavioural category, given that almost no other subject chose this style of play (only subject 18 in experiment DY1, none in experiment DY2 and in experiment DY3, and only 1 in experiment DY4).

I used a two-step methodology to classify the experimental subjects into homogeneous categories. In the first step I constructed new data-bases, one per experiment, which included 30 cases (each case was an individual subject), each of which characterised by seven variables chosen as proxies for the following attributes:

1) NU_{EVA} = number of tax evasions during the experiment $\rightarrow$ proxy for the degree of stability of the risk attitude;

2) AV_{EVA} = average amount of money evaded during the experiment → proxy for the absolute risk propensity;

3) SD_{EVA} = standard deviation of tax evasion → proxy for the degree of variability of the risk propensity;

4) FINE = total amount of fines paid during the whole experiment → proxy for the total deterrent effect played by the punishment system;

5) N_{FINE} = number of fines paid during the experiment → proxy for the frequency of direct experience of the punishment system;

6) R_{SQ} = Regression coefficient computed by interpolating the amount of money evaded in each round with a quadratic curve computed by using time as the only independent variable → proxy for the degree of similarity of the individual tax payment trend with the best interpolating function for the whole population;

7) Y_{CUM} = Total income cumulated at the end of the experiment → proxy of the degree of success of the game strategy chosen by the subject.

In the second step of the procedure I ran a cluster analysis using the variables just listed. The broad idea followed in this analysis was that the dynamic behaviours of the subjects could be captured by a set of variables summarising the most important characteristics of the behaviours themselves. The values assumed by these variables should then help to group the subjects into homogenous categories of behaviour.

Among the possible methods available to build clusters made up of homogeneous categories, I decided to use the average linkage between groups method (also called IPGMA, unweighted pair-group method using arithmetic averages) and to run the cluster using standardised variables. The use of standardised variables is common in cluster analysis, given that all cluster techniques are based on some form of comparison between distances, so that variables measured with large numbers influence the computation of distances more than do variables measured with small numbers. The standardisation method chosen is a technique built into the statistical package that I used to run the cluster analysis. It is based on a system of scores with a mean of 0 and standard deviation of 1. The algorithm adopted by the software (SPSS) subtracts the mean from each value of the variable being standardised, and then divides by the standard deviation of the values. If a standard deviation is 0, all values are set to 0.

A common way to represent the results obtained from a cluster analysis is to plot a so-called dendogram. The dendogram plotted running a cluster analysis using the standard experiment data is reported in fig. 5.23.

The dendogram gives a graphical representation of the links tying the groups of subjects constructed using the variables just described. Since the clusters move from the highest level of scattering to the lowest (in the end, there is only one large cluster which includes all the subjects), the problem is finding a good compromise between the number of clusters obtained (reasonably small) and the degree of similarity of the subjects included. One way to solve this problem is to inspect the distance that separate the clusters. This distance (re-scaled to fall within the range of 1 to 25) is measured on the horizontal axis and one is helped in the choice of the best number of clusters by seeing when it becomes fairly large. A possible level of "cutting" the clusters is represented by the dashed line in fig. 5.23 and corresponds to four groups of subjects and to four isolated cases (the subjects labelled 3, 8, 15 and 28) representing clusters consisting of only one subject. Some summarising statistics on the clusters are given in table 5.6, where the variables used to run the cluster analysis have been augmented by two new variables: $NTOT_{EV}$ which reckons the number of total evasions and $NTOT_{PAY}$ which sums the number of times that the subjects paid the total amount of tax due.

Fig. 5.23 Dendrogram Standard Experiment (DY1)

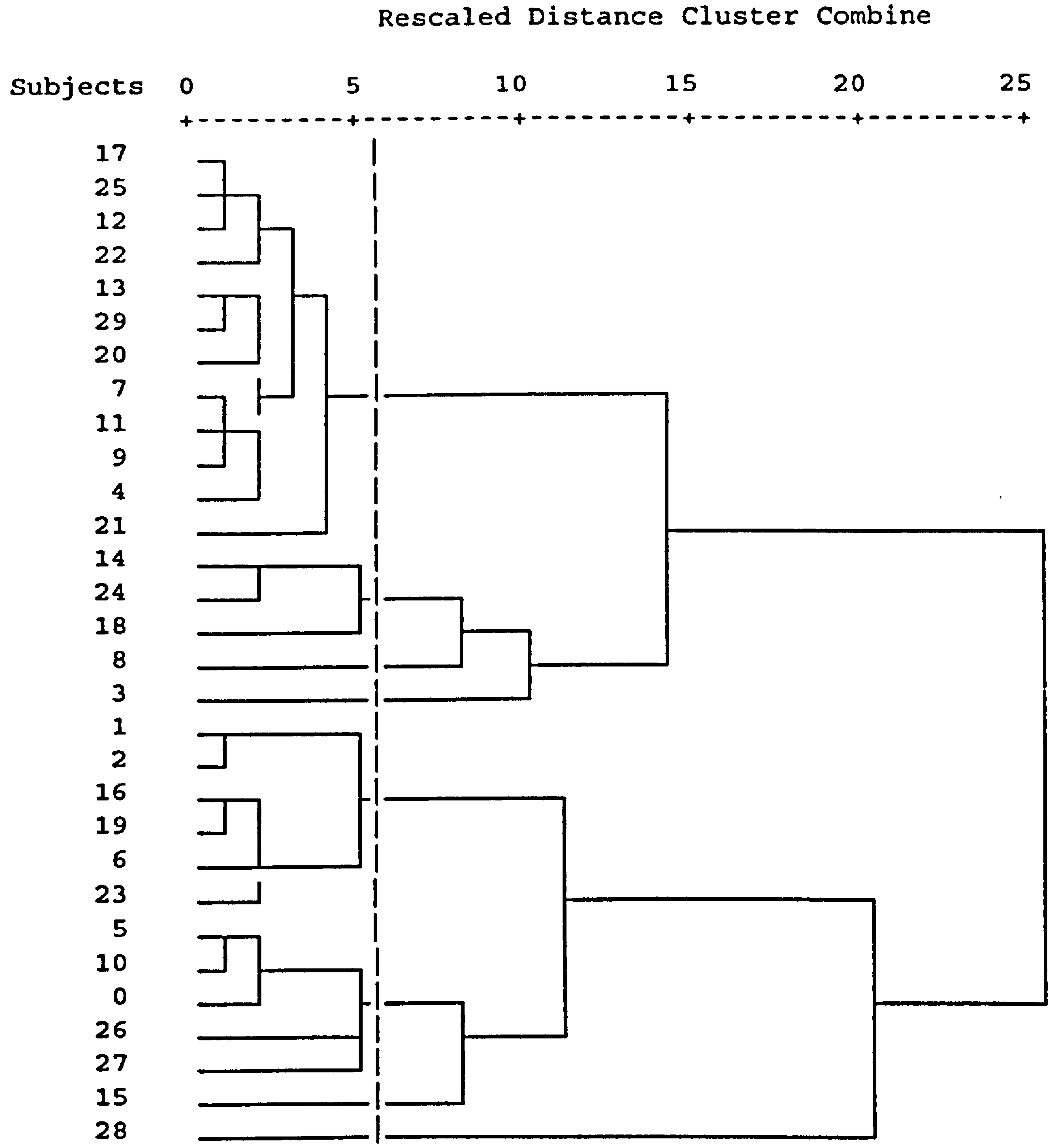
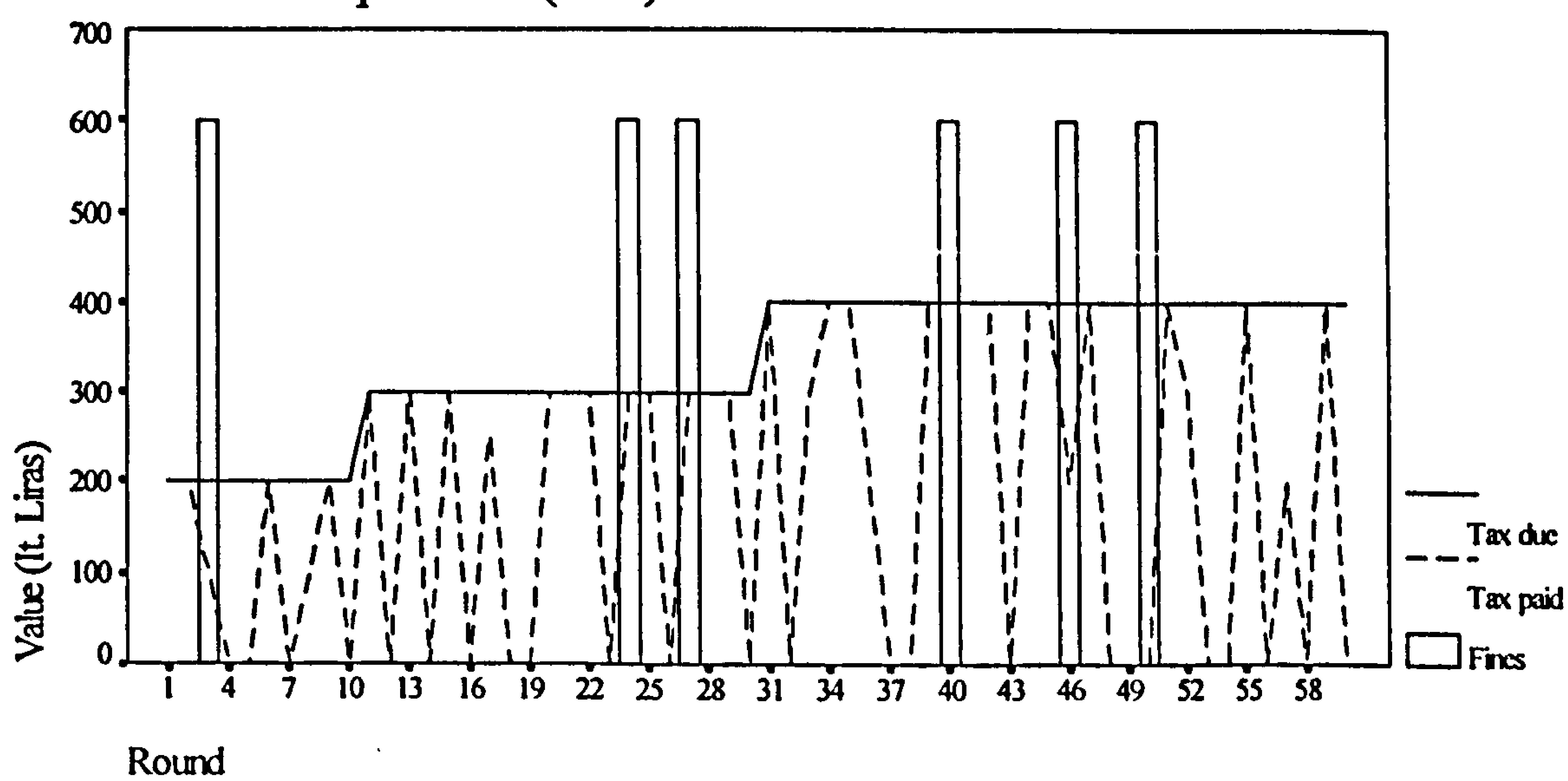


Table 5.6 can be used to give a definition for the four clusters with more than one subject. The largest is cluster 4 which collects 12 subjects displaying behaviour that could be called "totally evade once, then pay the entire tax one or more times". The variables reported in the two last columns of table 5.6 show that the average number of total tax evasions for cluster 4 is 19.5 while the average number of total payments (i.e. when the subject pays the entire tax due) is 22.16. This means that the subjects belonging to this cluster tend to oscillate between two opposite kinds of choice with an almost perfect ratio of 1:1. The best example of this kind of behaviour is provided by the graph of tax payments by subject 17 (fig. 5.24), who with only three exceptions (rounds 17, 46 and 57) always either paid the whole tax or totally evaded.

Tab. 5.6 Standard experiment (DY1): summary statistics for 8 clusters

Clusters		NUEVA	AVGEVA	SDEVA	YCUM	FINE	NFINE	RSQ	NTOTEV	NTOTPAY
1	Mean	24.0000	285.9820	112.8320	33774.2000	5466.8000	5.8000	.3666	3.2000	36.0000
	N	5	5	5	5	5	5	5	5	5
	Std. Deviation	9.4604	15.9959	11.2782	1872.0614	2780.8774	1.0954	.1809	2.2804	9.4604
2	Mean	7,0000	305.5833	112.4000	34050.0000	4015.0000	2.1667	.4288	4.0000	53.0000
	N	6	6	6	6	6	6	6	6	6
	Std. Deviation	2.5298	14.0681	16.3561	1386.3621	1785.5951	1.1690	.1421	2.8284	2.5298
3	Mean	58.0000	168.5000	53.0100	21760.0000	33330.0000	6.0000	.3740	.0000	2.0000
	N	1	1	1	1	1	1	1	1	1
	Std. Deviation	.	.	.	.	.	.	.	.	.
4	Mean	37.8333	178.6233	150.7242	26155.9167	19526.7500	5.8333	.1003	19.5000	22.1667
	N	12	12	12	12	12	12	12	12	12
	Std. Deviation	7.5297	20.7967	16.4175	2991.3734	3761.6282	.3892	7.930E-02	6.3889	7.5297
5	Mean	51.0000	54.1700	95.8000	8875.0000	44275.0000	6.0000	.1960	44.0000	9.0000
	N	1	1	1	1	1	1	1	1	1
	Std. Deviation	.	.	.	.	.	.	.	.	.
6	Mean	55.6667	120.4233	113.6467	19178.3333	29996.3333	6.0000	.1277	19.6667	4.3333
	N	3	3	3	3	3	3	3	3	3
	Std. Deviation	3.7859	31.7935	28.7626	2493.2626	1768.7878	.0000	8.950E-02	12.0968	3.7859
7	Mean	59.0000	234.5000	94.5900	29185.0000	13145.0000	6.0000	.2830	2.0000	1.0000
	N	1	1	1	1	1	1	1	1	1
	Std. Deviation	.	.	.	.	.	.	.	.	.
8	Mean	.0000	333.3300	75.1600	36400.0000	.0000	.0000	.8940	.0000	60.0000
	N	1	1	1	1	1	1	1	1	1
	Std. Deviation	.	.	.	.	.	.	.	.	.
Total	Mean	31.7000	218.6220	123.5583	28026.5667	15549.4667	4.9333	.2580	12.6333	28.3000
	N	30	30	30	30	30	30	30	30	30
	Std. Deviation	18.5587	76.1005	29.8663	6622.1519	11326.1629	1.8925	.2136	11.4846	18.5587

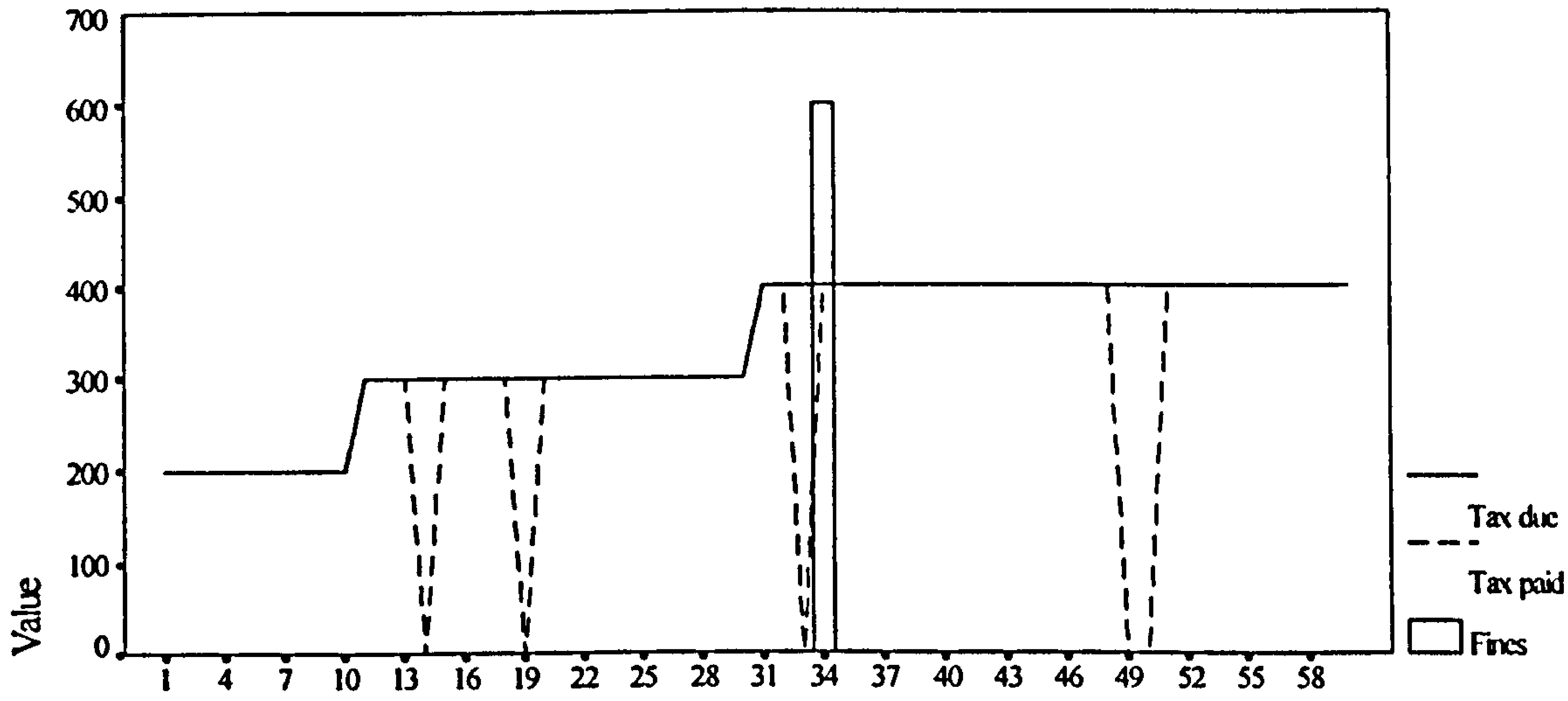
Fig. 5.24 Tax payments subject 17 (Cluster 4)
Standard experiment (DY1)



The second cluster by number of members is cluster 2, which includes 6 subjects whose behaviour can be called "mainly pay the whole tax due and sometimes evade the entire tax". Again looking at table 5.6, one notes that the average number of total payments for subjects belonging to this cluster is 36, while the average number of total evasion is 3.6. This behaviour is therefore the reverse of that chosen by the subjects belonging to the previous cluster (cluster 4), because these subjects show a tendency to adopt fundamentally stable behaviours, while those belonging to cluster 4 continuously oscillate between totally opposite choices. Confirmation of this profound difference is provided by the values of the regression coefficient, which is very low for cluster 4 (R_{SQ} = 0.1) and much higher (the highest of all clusters with more than one subject) for cluster 2 (R_{SQ} = 0.42). This difference in the values of R_{SQ} is closely related to the different styles of game, since the quadratic curve used to interpolate the individual strategies of game cannot fit a continuously oscillating behaviour such as that followed by the subjects belonging to cluster 4.

Although I have distinguished between oscillatory behaviour and stable behaviour it would be more correct to say, for the sake of precision, that both the clusters identify "stable" behaviours, in the sense that the subjects belonging to both these clusters never change their strategy of play throughout the entire duration of the experiment. The fundamental difference between the two clusters is therefore that members of cluster 4 chose a pendulum behaviour, as opposed to the quasi-perfect constant behaviour selected by the subjects of cluster 2. As previously noted, the large majority of subjects choose to follow the same strategy for the whole duration of the experiment (an exception to this rule, already commented on, was subject 8, fig. 5.22), and it seems that the only learning process undergone by the subjects is represented by an increase in the frequency of evasions during the course of the experiment for those who experienced the first audit at round 13 instead of round 3. A good example of the game style chosen by the subjects of cluster 2 is shown by fig. 5.25.

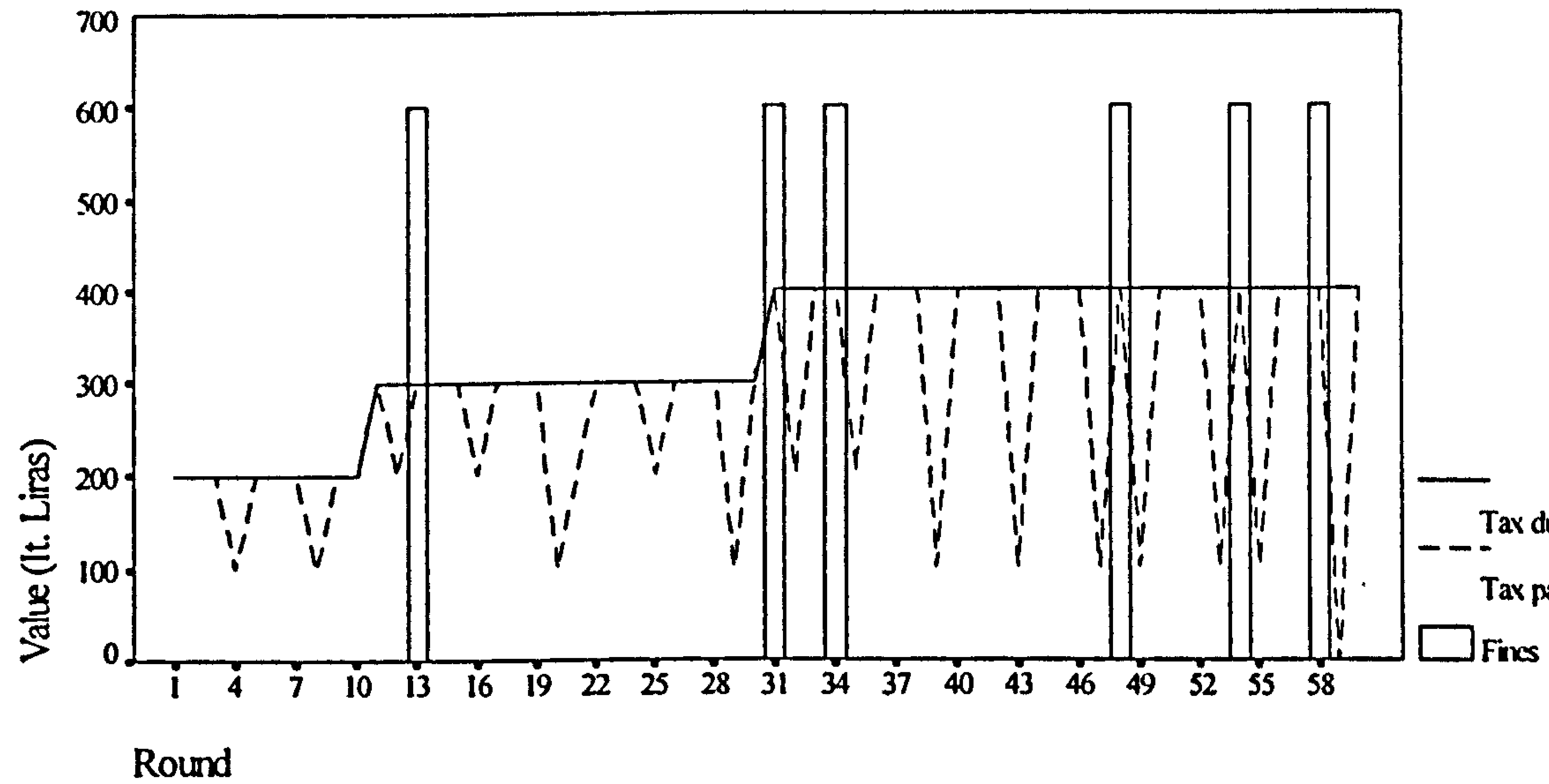
Fig. 5.25 Tax payments subject 1 (cluster 2)
Standard experiment (DY1)



The other two clusters with more than one subject are cluster 1, with 5 subjects, and cluster 6 with 3 subjects. Cluster 1 collects experimental subjects whose behaviour has some affinity with the behaviour of the subjects of cluster 4 and which could be "once evade *a part* of the tax due, then pay the entire tax one or more times". The main difference with respect to cluster 4 is that the members of cluster 1 almost never evade the whole amount of the tax due, while the subjects in cluster 4 almost never evade less than the entire tax. Another difference between the two clusters is that the members of cluster 1 alternate payments and evasions in a ratio which weakly privileges tax payments compared with tax evasion (the average number of tax evasions, measured by variable NU_{EVA} of table 5.6, is 24, which corresponds to 40% of the total number of rounds), while the subjects belonging to cluster 4 weakly prefer to evade rather than pay (NU_{EVA} computed for cluster 4 is 37.8). An example taken from the subjects belonging to cluster 4 is given in fig. 5.26.

Fig, 5.26 Tax payments subject 10 (cluster 1)

Standard experiment



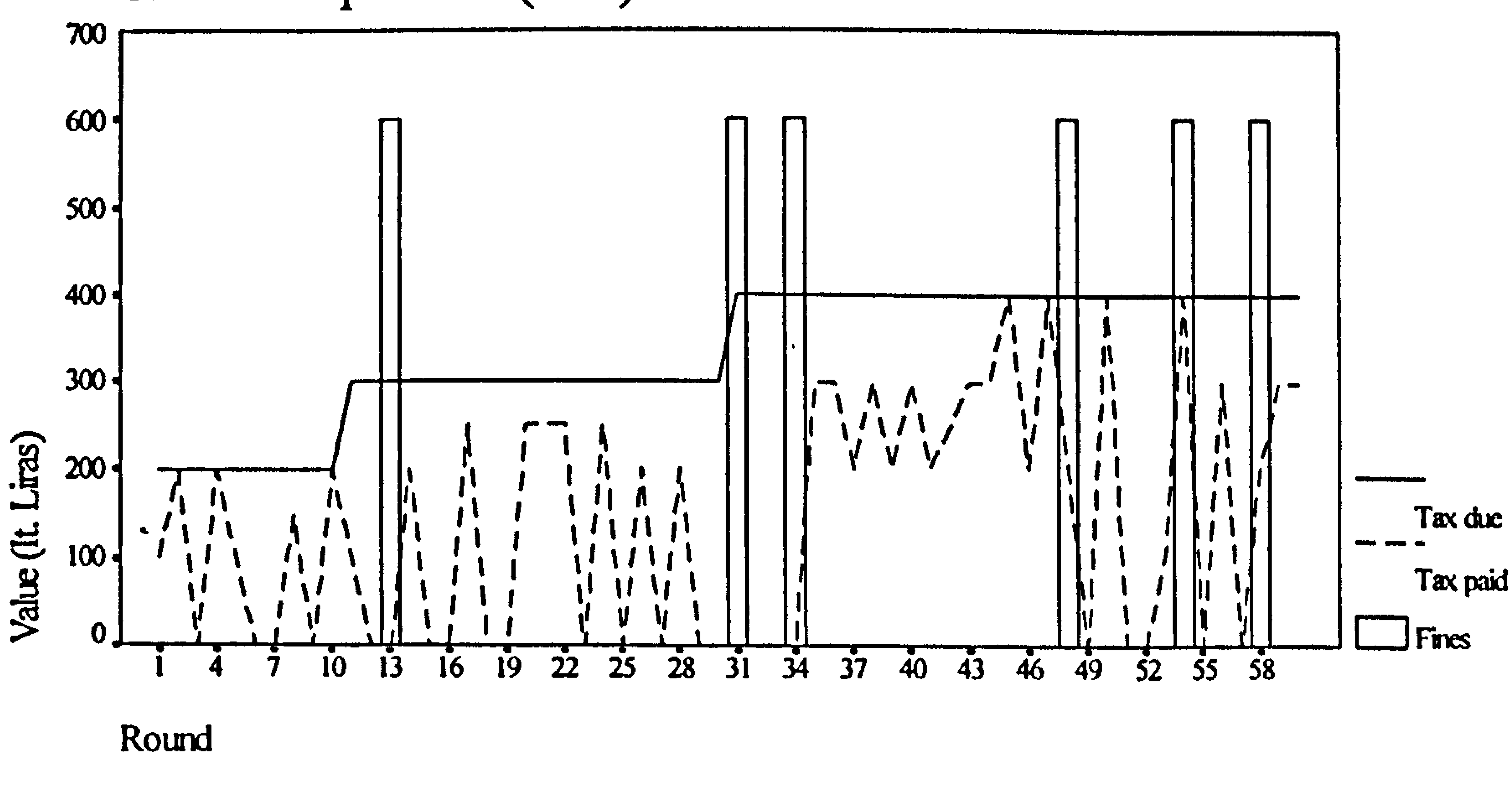
While cluster 1 can be considered a sort of subgroup of cluster 4, this is not the case of cluster 6, which, although very small, must be kept apart because it represents a quite different category of behaviour. This cluster could be labelled "mainly evade the whole amount of tax due or a part of it and sometimes pay". The value of NU_{EVA} for cluster 6 is 55.6, which means that the subjects belonging to this cluster paid, on average, the entire tax less than five times during their experimental lives. An example of the behaviour adopted by the subjects belonging to cluster 6 is shown in fig. 5.27.

Having discussed the four clusters with more than one subject, explanation is required of the fact that four subjects apparently do not fit any of these four clusters. First of all, one should bear in mind that cluster analysis is a sort of "qualitative" statistical method that requires careful interpretation of the results.

Referring once again to the dendogram reported in fig. 5.23, one notes that two of the isolated subjects, specifically subject 8 and subject 15, should respectively join cluster 6 and cluster 1 if the rescaled distance increases from 5.5 to 8.5. Unfortunately, both these aggregations can be criticised, albeit for different reasons. In the case of subject 8, I have already pointed out that s/he displays a very special behavioural pattern, having adopted a sort of dichotomous strategy which split his/her experimental life into two separate periods. On the other hand, none of the subjects in cluster 6 ever chose to change his/her game style at any stage of the experiment (for the sake of precision, the only subject that can be coupled with subject 8 is subject 24, who at the end of the experiment decided always to evade the whole tax, but s/he took this decision only after the 50th round, while subject 8 started this strategy at round 29, i.e. in the middle of the experiment).

The difficulty of joining subject 15 to cluster 1 derives from the fact that, in spite of the values assumed by some of the variables used by the cluster analysis, this subject actually behaved in a way much more similar to that followed by the subjects belonging to cluster 6. Inspection of table 5.6 shows that, with the exception of NU_{EVA}, no other variable of cluster 6 has values nearer to the values of subject 15 (who corresponds to cluster 7 in table 5.6) than to those assumed on average by the subjects belonging to cluster 1. Nevertheless, it is clear from the graph of tax payments by subject 15 (reported in fig. 5.28) that his/her game style is very similar to that of the subjects in cluster 6 ("almost never pay; almost always evade the whole amount of tax due or a part of it") and quite different from that adopted by the subjects belonging to cluster 1 ("evade a part of the tax due once, then pay all the burden one or more times").

Fig. 5.27 Tax payments subject 14 (cluster 6)
Standard experiment (DY1)



Finally we must consider the two remaining isolated subjects, i.e. subject 3 (fig. 5.29) and subject 28. Subject 3 could be included in cluster 6, but this time in accordance with the dendogram that actually puts subject 3 very near to cluster 6, while subject 28 should be left alone because of her/his uniqueness for this experiment. In spite of the statistical good proximity of subject 3 with the behaviours of the subjects belonging to cluster 6, it is worth stressing that his/her style of game also shows a deep difference with the way of playing of the other subjects of cluster 6. This difference regards his/her tendency to adopt highly constant behaviour, while his/her cluster mates follow an oscillatory strategy very similar to that adopted by the majority of the experimental subjects of all the clusters. From an economic point of view, the behaviour of subject 3 can be coupled with that of subject 28, i.e. of the only subject who decided to always pay the entire tax. The difference between these two subjects is in fact one of of different risk propensities, but they share a common way of interpreting the game by looking at the lotteries structure, which in fact does not change with each round but remains constant for quite long periods.

The conclusion is that the final number of clusters can be reduced to four clusters with more than one subject (clusters 1, 2, 4, 6 with the inclusion of subject 3, subject 15 and subject 8) plus a cluster with only one subject i.e. subject 28. Finally, it is worth stressing that the initial taxonomy of behaviours suggested at the beginning of this section captured only a part of the entire repertoire of strategies used by the subjects.

Fig, 5.28 Tax payments subject 15 (cluster 7)
Standard experiment (DY1)

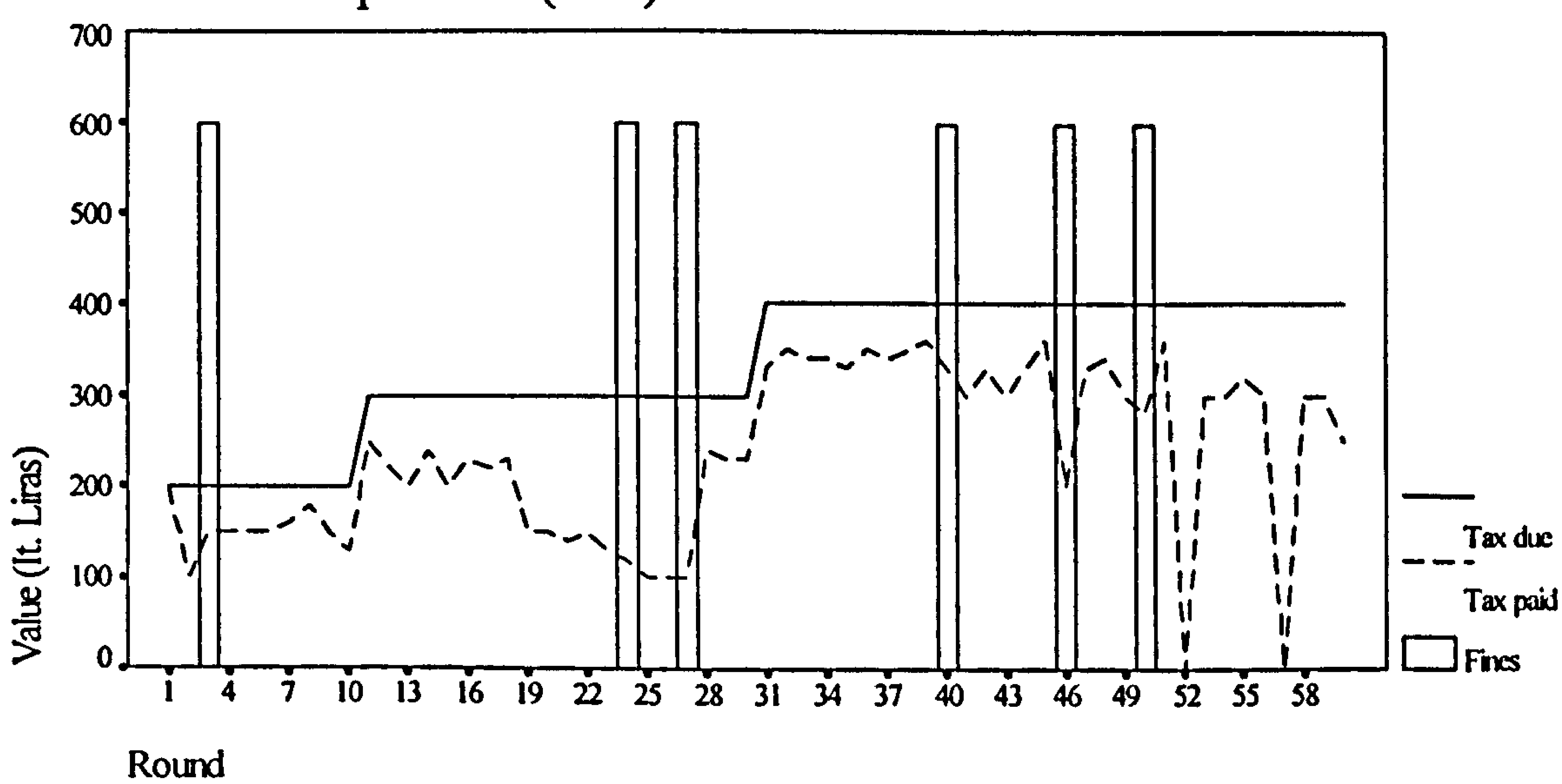
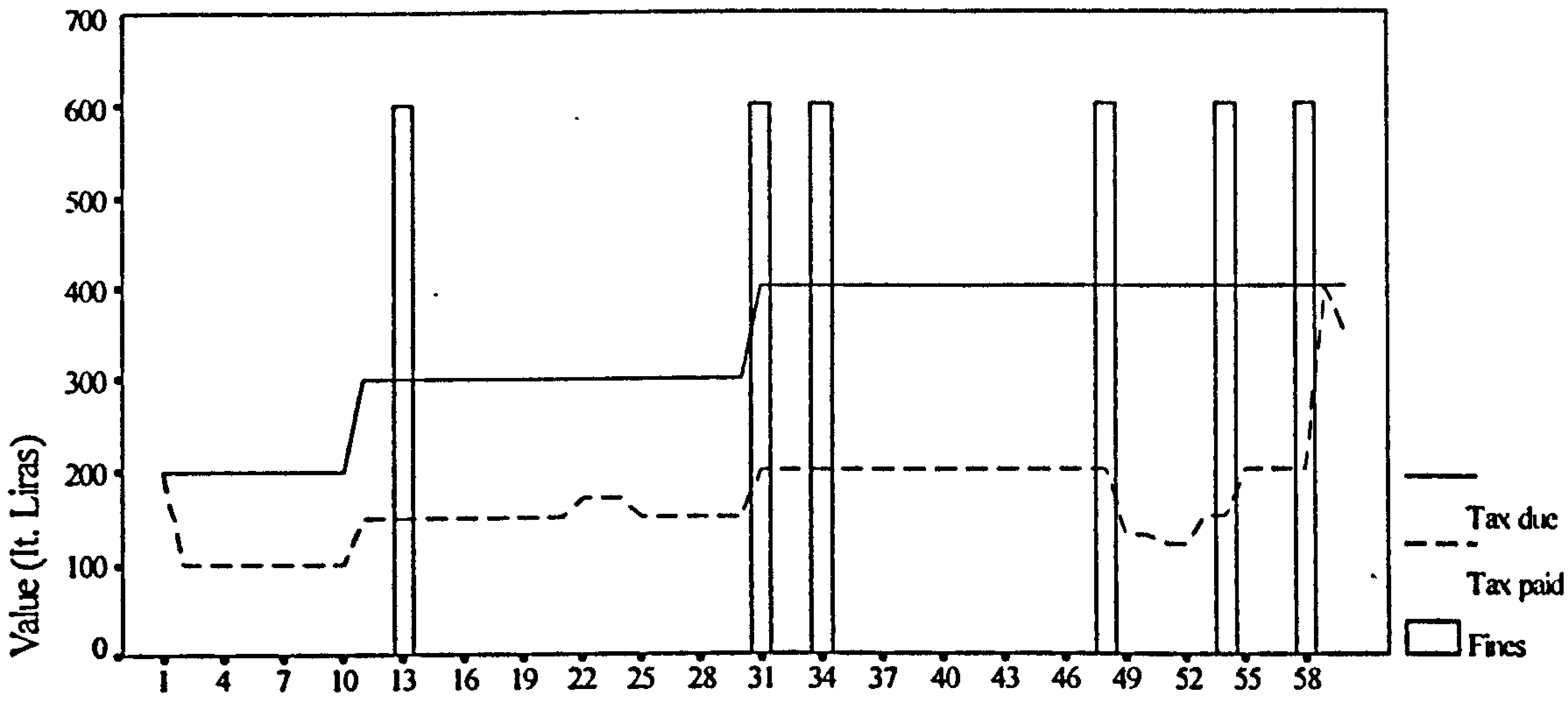


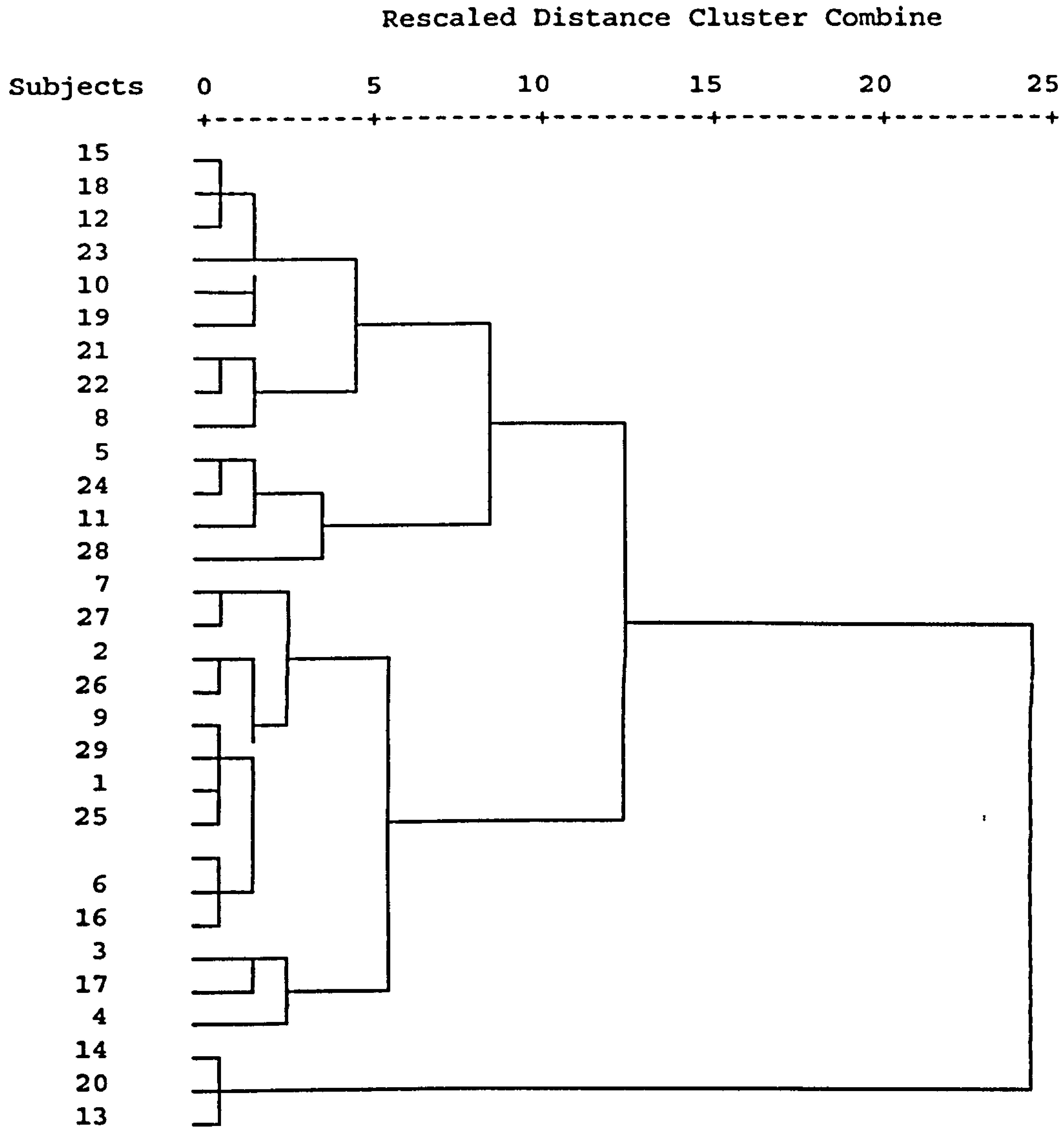
Fig. 5.29 Tax payments subject 3 (cluster 3)
Standard experiment (DY1)



One way to test the robustness of the taxonomy just constructed is to carry out a cluster analysis using the data from other experiments and see whether the clusters contain groups of behaviours similar to those obtained with the data from the standard experiment. Obviously, one cannot expect the result to be a perfect fitting of the original categories, given that cluster analysis always requires some form of interpretation, which inevitably requires some degree of adaptation of the original taxonomy. This also means that comparisons among different experiments, for example in order to compare the numerousness of similar clusters, requires great caution.

The aggregate results from the experiment with tax yield redistribution (DY2) are those that differ most from those obtained by the standard experiment. Conversely, the gamble experiment produced aggregate results that were the most similar to those from the standard experiment. Starting from the dendogram plotted by performing a cluster analysis (fig. 5.30) on the gamble experiment (obviously using the same variables just used for the standard experiment), one immediately notices that "cutting" the dendogram at the same distance chosen for the dendogram plotted for the standard experiment yields only five clusters, instead of the eight as in the case of experiment DY1. To obtain the same number of clusters it is therefore necessary to reduce the distance between the clusters. The results for eighth clusters are given in table 5.7.

Fig. 5.30 Dendogram Gamble Experiment (DY4)



By comparing table 5.7 with table 5.6, we can attempt to derive some correspondences among the clusters from the two experiments. Recalling the results obtained from the standard experiment, we have the following main categories (clusters) of behaviour:

a) category 1TE1P "totally evade once, then pay the entire tax one or more times";

b) category MPSE "mainly pay the whole tax due and sometimes evade the entire tax";

c) category 1E1P "evade a part of the tax due once, then pay the entire tax one or more times";

d) category MESP "mainly evade the whole amount of tax due or a part of it and sometimes pay";

e) category AP "always pay".

With the exception of category AP, which is a "pure" category, all the other categories include a moderate mix of behaviours which more or less closely approximate the label just suggested. This means that if a category becomes sufficiently differentiated, it can give rise to two or more other sub-categories, and this possibility increases as we expand the total number of subjects considered. For example, subject 18, who as we saw at the beginning of this section never paid and was included in cluster 6, could become a member of a sub-category of category 4 (or give origin to a new category) if we find some other subjects who adopted his/her game style.

By comparing the results from other experiments we do exactly as just described: we enlarge the number of subjects analysed and consequently we also increase the possibility of distinguishing among sub-categories of behaviour. By comparing the table 5.6 with table 5.7, which reports the results from the cluster analysis run using the data from the gamble experiment, we can build a broad structure of correspondences between the clusters of these two experiments (table 5.8).

Tab. 5.7 Gamble experiment (DY4): summary statistics for 8 clusters

Cluster		NUEVA	AVGEVA	SDEVA	YCUM	FINE	NFINE	RSQ	NTOTEV	NTOTPAY
1	Mean	42,1818	157,7833	143,8024	24691,8182	21175,1818	6,0000	,1225	17,2727	17,8182
	N	11	11	11	11	11	11	11	11	11
	Std. Deviation	9,2824	22,9582	16,9929	2423,2641	2532,4960	,0000	5,826E-02	6,7689	9,2824
2	Mean	53,5000	220,2500	129,9111	20132,5000	29482,5000	6,0000	2,300E-02	19,0000	6,5000
	N	2	2	2	2	2	2	2	2	2
	Std. Deviation	4,9497	28,4021	23,8600	1933,9370	229,8097	,0000	5,657E-03	21,2132	4,9497
3	Mean	59,0000	262,4333	97,8323	14153,0000	37993,0000	6,0000	1,200E-02	13,0000	1,0000
	N	1	1	1	1	1	1	1	1	1
	Std. Deviation	.	.	.	.	.	.	.	.	.
4	Mean	31,6667	38,3889	52,4909	35128,6667	3574,6667	5,6667	,6807	2,0000	28,3333
	N	3	3	3	3	3	3	3	3	3
	Std. Deviation	8,5049	7,3226	5,5317	1078,1078	1448,4151	,5774	,1143	,0000	8,5049
5	Mean	11,3333	55,0000	124,2943	32916,6667	6783,3333	3,3333	,2523	9,6667	48,6667
	N	3	3	3	3	3	3	3	3	3
	Std. Deviation	3,0551	14,1313	6,7977	1543,2865	2222,7985	1,1547	7,023E-02	3,2146	3,0551
6	Mean	31,3333	93,4167	117,7741	30425,8333	11579,1667	6,0000	,2703	9,0000	28,6667
	N	6	6	6	6	6	6	6	6	6
	Std. Deviation	8,1158	25,5590	14,4846	1168,4409	2484,6235	,0000	,1318	3,8471	8,1158
7	Mean	1,6667	8,8778	55,1748	35466,0000	1466,6667	,6667	,5917	1,3333	58,3333
	N	3	3	3	3	3	3	3	3	3
	Std. Deviation	1,1547	3,8298	6,1228	1172,2918	1270,1706	,5774	4,382E-02	,5774	1,1547
8	Mean	60,0000	68,7500	73,3556	31230,0000	9295,0000	6,0000	,6250	5,0000	,0000
	N	1	1	1	1	1	1	1	1	1
	Std. Deviation	.	.	.	.	.	.	.	.	.
Total	Mean	33,7333	112,4867	113,8454	28344,9000	14804,3000	5,1667	,2742	11,3000	26,2667
	N	30	30	30	30	30	30	30	30	30
	Std. Deviation	17,5321	69,6900	36,6992	5721,7509	9693,9439	1,7633	,2298	8,6189	17,5321

Analysing table 5.8, one finds that the original categories should be supplemented with at least two new categories or sub-categories of existing ones. These two new sub-categories are represented by cluster 6 and cluster 7 of the gamble experiment. Cluster 6 of the gamble experiment represents a sort of mix between category 1TE1P and category 1E1P, because the data (and individual graphs, like that of subject 10 reported in fig. 5.31) shows that the strategy followed by the subjects is something like " totally evade once, then pay the whole tax due, then evade a part of the tax, then pay the entire tax", and so on, following the usual quasi-cyclical path.

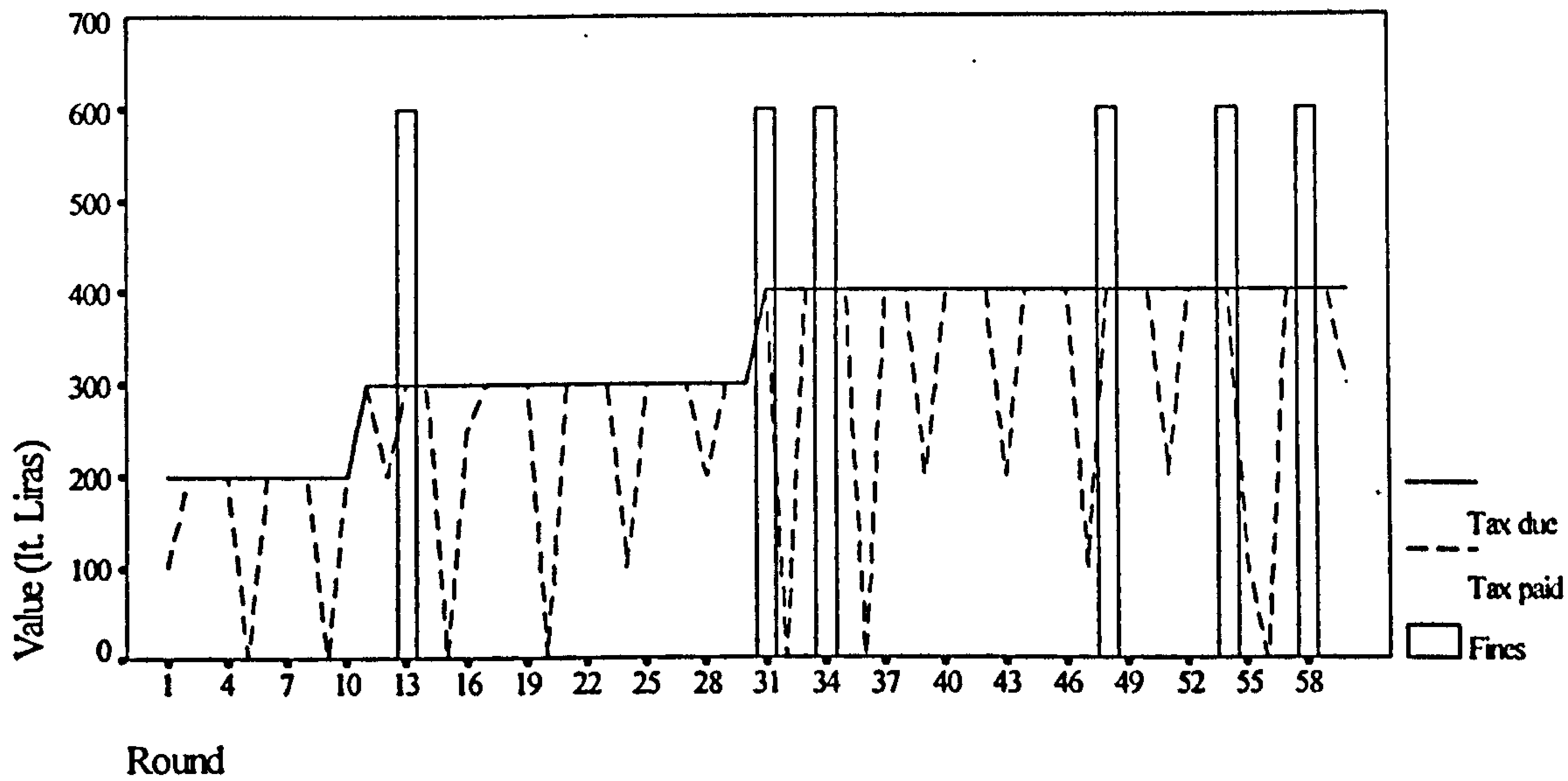
Table 5.8 Correspondences among clusters: standard and gamble experiments

Categories	Standard experiment	Gamble experiment	Mann-Whitney test
cat. 1TE1P "totally evade once, then pay the entire tax one or more times"	cluster 4; 12 subjects	cluster 1; 11 subjects; cluster 6; 6 subjects (as a mixed sub-category)	good
cat. MPSE "mainly pay the whole tax due and sometimes evade the entire tax"	cluster 2; 6 subjects	cluster 5; 3 subjects; cluster 7; 3 subjects (it could become a sub-category)	very good
cat. 1E1P "evade a part of the tax due once, then one or more times pay the entire tax"	cluster 1; 5 subjects	cluster 4; 3 subjects	good
cat. MESP "mainly evade the whole amount of tax due or a part of it and sometimes pay"	cluster 6; 3 subjects + cluster 3; 1 subject + cluster 5; 1 subject + cluster 7; 1 subject	cluster 2; 2 subjects + cluster 3; 1 subject	good
cat. AP "always pay"	cluster 8; 1 subject		

On the other hand, cluster 7 of the gamble experiment, unlike cluster 6, can be viewed as an "extreme" sub-category of category MPSE, because the subjects belonging to this cluster have evaded in only one or two rounds.

One way to verify whether the correspondences shown in table 5.8 are statistically significant is to compute the Mann-Whitney test, which allows one to check if the samples corresponding to the clusters linked in the categories of table 5.8 can be considered as extracted by the same statistical population.

Fig. 5.31 Tax payments subject 10
Gamble experiment (DY4)



The results from the Mann-Whitney test are reported in the appendix and are summarised here with a qualitative judgement in the last column of table 5.8. The meanings of the qualitative judgements are the following:

very good = acceptance of the hypothesis that the samples are extracted from equally distributed populations for 6 or more of the cluster variables;

good = acceptance of the hypothesis that the samples are extracted from equally distributed populations for at least 4 of the cluster variables;

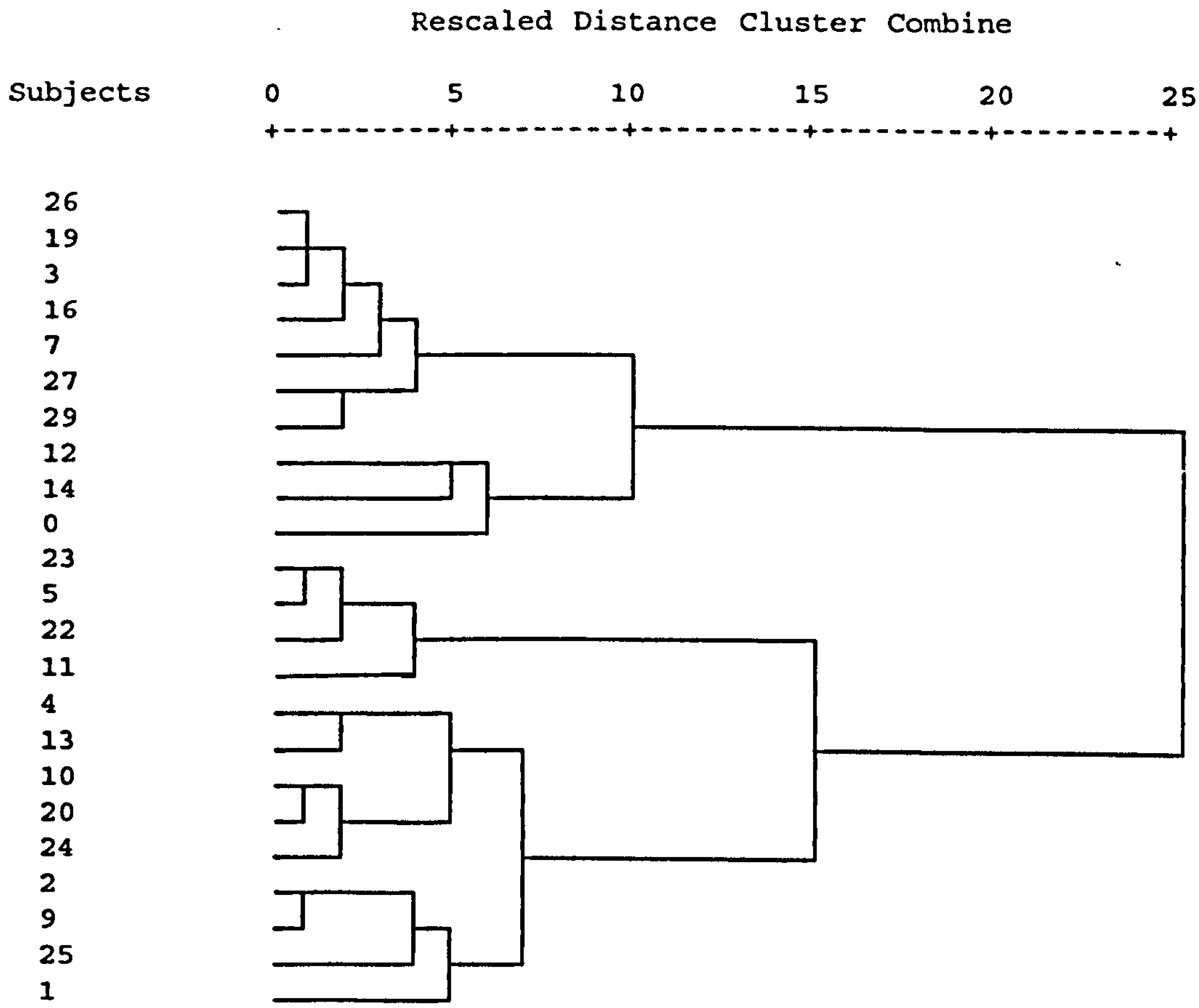
fairly bad = acceptance of the hypothesis that the samples are extracted from equally distributed populations for 3 cluster variables

bad = acceptance of the hypothesis that the samples are extracted from equally distributed populations for 2 or less cluster variables.

The overall results obtained from the Mann-Whitney test are good. We may therefore conclude that the categories built using the findings of the cluster analysis applied to the standard experiment can reasonably include also the subjects belonging to the clusters of the gamble experiment. As we have just seen, two new sub-categories could be added to the original ones. But the Mann-Whitney test has been computed by aggregating the sub-categories, and therefore the good results refer to the original categories as if they included the subjects belonging to the new ones.

The final step in this discussion is to compare the results from the cluster analysis computed using the data of the experiment with tax yield redistribution (DY2) with those of the standard experiment.

Fig. 5.32 Dendrogram Experiment with Redistribution (DY2)



The cluster analysis applied to the data of the experiment with redistribution has been conducted using only 23 subjects, because 7 subjects of this experiment belong to the "pure" category AP (always pay) and can be therefore be excluded from the sample. Consequently, the dendogram (reported in fig. 5.32) must be split into 7 clusters. This yields 4 clusters with more than one subject and 3 individual clusters (subjects 0, 12 and 14 who coincide respectively with clusters 1, 6 and 7), while in the standard experiment there were 4 individual clusters. Comparing table 5.6 with table 5.9, it is this time rather more difficult to find clusters from the standard experiment which look sufficiently similar to some cluster of the redistribution experiment for them to be joined in a common category.

Tab. 5.9 Redistribution experiment (DY2): summary statistics

Cluster		NUEVA	AVGEVA	SDEVA	YCUM	FINE	NFINE	RSQ	NTOTEVA	NTOTPAY
1	Mean	25,0000	121,6667	157,0000	20600,0000	3100,0000	4,0000	,2330	20,0000	35,0000
	N	1	1	1	1	1	1	1	1	1
	Std. Deviation	.	.	.	.	.	.	.	.	.
2	Mean	19,2500	61,5125	119,2500	32281,0000	7809,7500	5,2500	,2938	9,2500	40,7500
	N	4	4	4	4	4	4	4	4	4
	Std. Deviation	6,2383	25,3489	29,1018	1392,8419	2361,4431	,5000	,1456	4,3493	6,2383
3	Mean	32,7143	112,7976	141,0000	29386,4286	3781,4286	5,7143	,1677	12,4286	27,2857
	N	7	7	7	7	7	7	7	7	7
	Std. Deviation	5,4380	17,5609	22,3458	1294,6837	1593,6899	,7559	,1151	5,6526	5,4380
4	Mean	12,8000	49,0833	108,2000	34714,0000	4631,0000	2,4000	,3232	7,2000	47,2000
	N	5	5	5	5	5	5	5	5	5
	Std. Deviation	5,5857	28,6469	31,5785	1288,8726	1903,8264	,5477	6,063E-02	6,4962	5,5857
5	Mean	6,2500	7,9875	36,0000	35820,5000	1058,7500	1,7500	,7388	,5000	53,7500
	N	4	4	4	4	4	4	4	4	4
	Std. Deviation	3,4034	3,8745	17,0294	941,0443	1032,2578	1,2583	,1295	,5774	3,4034
6	Mean	34,0000	183,3333	179,0000	19350,0000	8050,0000	6,0000	2,100E-02	28,0000	26,0000
	N	1	1	1	1	1	1	1	1	1
	Std. Deviation	,	,	,	,	,	,	,	,	,
7	Mean	45,0000	126,2500	125,0000	20050,0000	3925,0000	6,0000	,1800	6,0000	15,0000
	N	1	1	1	1	1	1	1	1	1
	Std. Deviation	,	,	,	,	,	,	,	,	,
Total	Mean	21,6957	75,8370	113,4783	30942,6522	0007,5652	4,1739	,3197	9,3913	38,3043
	N	23	23	23	23	23	23	23	23	23
	Std. Deviation	12,4003	50,3078	45,8762	5115,0183	7758,2151	1,8745	,2327	7,6678	12,4003

Table 5.10 reports the clusters from the redistribution experiment which fit the original categories constructed by using the standard experiment data. The categories shared by both the experiments are category 1TE1P, category MPSE and category 1E1P. Note that categories 1TE1P and MPSE are those with the highest number of members for all the three experiments, and they can therefore be considered to be the two dominant types of behaviour. Note also that cluster 5 from the redistribution experiment should be considered a sub-category of MPSE because the subjects belonging to this cluster mainly pay the whole amount due (as do the members of MPSE), but the never totally evade the whole tax, while the majority of subjects belonging to MPSE alternate total payments with total evasions.

Table 5.10 Correspondences among clusters: standard and redistribution experiments

Categories	Standard experiment	Redistr. experiment	Mann-Whitney test
cat. 1TE1P "totally evade once, then pay the entire tax one or more times"	cluster 4; 12 subjects	cluster 3; 7 subjects;	good
cat. MPSE "mainly pay the whole tax due and sometimes evade the entire tax"	cluster 2; 6 subjects	cluster 4; 5 subjects; cluster 5; 4 subjects	very good fairly bad
cat. 1E1P "evade a part of the tax due once, then one or more times pay the entire tax"	cluster 1; 5 subjects	cluster 2; 4 subjects	very good
cat. MESP "mainly evade the whole amount of tax due or a part of it and sometimes pay"	cluster 6; 3 subjects + cluster 3; 1 subject + cluster 5; 1 subject + cluster 7; 1 subject		
cat. AP "always pay"	cluster 8; 1 subject	"artificial" cluster; 7 subjects	

In this way, 27 subjects from the redistribution experiment find systemisation, while 3 should be organised into a new category. On the other hand, on looking at fig. 5.32 we discover that these 3 subjects should form a single cluster, and that they have been split "artificially" because the software was forced to build 7 clusters. Unfortunately, this eighth cluster is difficult to interpret because its 3 members display behaviours that are only vaguely resemble each other, and are probably close in the dendogram only because they are not sufficiently similar to the other subjects to be joined to some other cluster. In fact, if we return to table 5.9 and look at the values of some variables (e.g. NU_{EVA} or AV_{EVA}), computed for subject 12, we find that this subject could be added to category 1TE1P as its "extreme" member, while in terms of the values of other variables s/he is too different from the other members. On the other hand, subject 0 may represent a mixed category midway between the mirror-like categories MESP and MPSE, because s/he chose to adopt a dichotomous strategy which alternated periods (lasting about10 rounds each) of strategy MESP and of strategy MPSE. Finally, subject 14 used a double strategy: in the first two thirds of her/his experimental life (until round 47) s/he played as if s/he belonged to category MESP but then decided to always evade the entire tax or a part of it.

5.4 Some conclusions from the individual data

Analysis of the individual data has shown even more clearly that the dynamic of the subjects' behaviours is almost impossible to explain using a traditional expected utility maximisation approach. At the same time, two interesting remarks can be made: the role played by the tax yield redistribution as a deterrent against tax evasion is confirmed, and common game styles exist.

The existence of a limited number (about 4-5 main categories) of common game styles suggests that it should be possible to find some form of general rule of behaviour on which to base a theoretical model of individual responses to this kind of decision frame. It is to be stressed that the choices made by the large majority of subjects are stable (or in other words, can be considered as a dynamic equilibrium), and that only very few subjects (for example, subject 8 in the standard experiment) changed game style during the experiment. Furthermore, the largest category for all the three experiments analysed is the one with the most cyclical dynamic, i.e. 1TE1P, and this suggests that when subjects must cope with a situation of repeated choices under risk, they find it very difficult to understand the probabilistic nature of the problem correctly. They therefore choose to alternate opposite choices (once evade the whole tax, once pay the whole tax). There is a strong suspicion that the dynamic experiments produced an environment which induced the subjects to re-model the probabilistic structure of the problem, and this could provide the starting point for a theory on the subjective modelling of probability under conditions of risk. It should be borne in mind, in fact, that the subjects were always perfectly informed about the nature of the lotteries confronting them, and therefore had to decide under conditions of risk, not of uncertainty (here accepting the classical Knight (1921) distinction between uncertainty and risk).

It seems that the cognitive complexity of the task assigned to the subjects of the dynamic experiments (the difficulty of computing the expected value of evasion for each round) artificially transformed a problem of decision-taking under given probability into a situation of uncertainty. This late consideration goes in the direction of the more recent criticism on the distinction between "subjective" and "objective" probabilities (Hirshleifer and Riley, 1992).

5.5 Normative lessons from cluster analysis

An interesting question concerns the possibility of using the five taxpayer categories identified by cluster analysis as a basis for the design of tax policies. To answer this question, one could consider two main fields of action for fiscal authorities: the first regards fiscal audit strategies, the second the design of the punishment scheme.

As is well known, a crucial problem for the tax authorities is how to reduce the administrative costs of carrying out fiscal audits. The best way to increase the efficiency of the fiscal police is to give them good "targets", that is, to reduce the number of unnecessary audits as much as possible, concentrating investigative effort only on high risk tax payers. For obvious reasons this selection cannot be performed by concentrating on individuals, but it is feasible if specific socio-economic categories are picked. Unfortunately, in modern societies socio-economic groups are generally very large - for example, from the researches discussed in chapter 1 we know that self-employed workers have more opportunities to evade income tax than employees, but the self-employed workers class is too large a group to be adopted as a specific category for fiscal audits - and they therefore do not allow the building of a good screening system. In this sense the results from cluster analysis just discussed can help to improve the effectiveness of the screening system. For example, one could investigate whether the opportunities to evade available to a specific socio-economic group and due to some imperfection in the tax system can fit with the most "dangerous" cluster category, i.e. cat. MESP (mainly evade the whole amount of tax due or a part of it and sometimes pay).

An example of this kind of correlation is provided by a sub-group of self-employed workers (e.g. some types of artisan: plumbers, painters, electricians, etc.) who derive their yearly earned incomes mainly by adding the payments of numerous small professional services. The parcelling out of the sources of earned income allows reproduction of a tax payment style which fits the MESP category because the tax payer has the opportunity to hide each single revenue by not invoicing her/his customers or by under-invoicing the real price.[1] Remembering that in all the repeated choices experiments discussed here the MESP category is one of the largest, and that the style of tax payment adopted by its members is stable behaviour, it seemed reasonable to conclude that a high percentage of tax payers belonging to the artisan class (and in all the other socio-economic groups with the same characteristics) will actually adopt the MESP strategy.

This conclusion may seem rather obvious and certainly not brand new: in fact, we do not need to run a cluster analysis to discover that craftsmen often make up part of the persistent tax evaders category. Nevertheless the results from cluster analysis just discussed suggest a special two-step fiscal audit strategy:

a) in the first step the fiscal authority carefully analyses whether the conditions of tax payment allowed to a given socio-economic group may give rise to MESP behaviours, making in this way a first selection of the potential candidates for fiscal audits;
b) in the second step, remembering that the tax payers belonging to the MESP category seemed very reluctant to change their style of tax evasion even when they have been detected and punished, the fiscal authority should put each tax payer discovered as MESP in a special "high risk" audit group, monitoring her/him with regularity.

It seemed reasonable to expect that this two-step procedure, and in particular the knowledge of running the risk of becoming a member not only of the "potential evaders category" but also of the very undesirable closely monitored group, should work as a strong deterrent to tax evasion.

Looking at the largest cluster category, i.e. cat. 1TE1P (totally evade once, then pay the entire tax one or more times) it is possible to draw another interesting lesson for modelling the audit strategy. The members of this category seemed unable to correctly evaluate the risk of being detected and punished, oscillating between two opposite behaviours, totally pay or totally evade, as if they were confronting a probability of being audited that changes dichotomously (once high probability then low probability), while, as we know, this kind of change never occurred in the experiments. Therefore a

[1] This form of tax evasion in very common in Italy, see the first chapter.

good audit strategy, aimed at contrasting their attitude to tax evasion, would be that of extending the tax audit over the longest period possible. This device should force the 1TE1P tax payers to build a mental representation of the probability of being audited on a sort of time continuum. The objective of this kind of fiscal audit policy should be to convince the tax payers that might potentially fall into the 1TE1P category to switch their behaviours to the AP (always pay) category, as a response to a probability of being punished perceived as constant over time.

The second area of intervention for the fiscal authorities that might benefit from the results of cluster analysis is that of the punishment system. The most effective punishment system against the most dangerous evader category, i.e. cat. MESP, is probably a progressive one. The tax evaders belonging to the MESP category do not care how many times they have been detected and punished, but this behaviour is probably due to the fact that the value of the fines in the experiments was independent of the number of tax evasions. This means that the fee applied to each tax evasion was always the same (4.5 times the amount of tax evaded), independently of how many times the tax payer had evaded. Changing this punishment system to a progressive one, that is, a system that increases the fines as the number of evasions detected increases (e.g. 4.5 for the first tax evasion, then 5.5 the second, 6.5 the third and so on), would probably break the behavioural pattern of MESP tax evaders.

Similarly also the tax evaders belonging to category 1TE1P could be contrasted by using a specific punishment system which applies higher fees when the tax evasion is total or very near to total. Admitting that these tax evaders have a problem in modelling the audit probability, and remembering that this cognitive (computational) constraint induces them to adopt a dichotomous behaviour: evade or pay the entire amount of tax due, a system that punishes total evasion very severely should break the basis of their strategy. This system in fact should force them, when they have decided to evade, to leave the easy choice of total evasion because it becomes much less dangerous to modulate the amount of money evaded. Given their computational limitations, this could increase the number of honest income declarations, because they do not involve any additional cognitive cost.

Unfortunately these late considerations are not explicitly supported by the experimental results and may therefore form the theme of further experiments.

A final question that can be asked by looking to the results from cluster analysis is the following: does exist some correlation between the styles of tax payments and some socio-economic indicators - like for example income, level of education and so on -? The finding of some relationship of this kind could help to concentrate the fiscal audits on the tax payers that have the highest probability to fall into the high risk categories. Unluckily I did not collect this kind of information about the experimental subjects and therefore I cannot verify this hypothesis unless I call back the experimental subjects for a supplementary enquiry. On the other hand it is worth remembering that all the subjects used in the experiments were university students, and therefore share many common socio-economic characteristics. It follows that they do not constitute the best possible sample to verify the existence of correlation between styles of evasion and many of the indicators just suggested.

6. Appendixes

6.1 Appendix A1

6.1.1 Instructions for the experimental subjects: ST1 experiment

These are the Instruction for group A: total anonymity, absence of any redistribution of tax yield:

"First of all we want to thank you for having answered the questions on the questionnaires we gave to you.

The reward for your work is in the envelope that you have just received. Inside the envelope, besides the money, you will find two tickets with a number, which will ensure your anonymity when you cash the reward.

As you know, the reward is proportional to the time you took and the amount of work you did in answering the questionnaires. In fact, some of you were given a larger number of questionnaires ('more work' state) than others ('less work' state). The members of the first group receive a reward of 60,000 lire, while the others receive 30,000 lire. Like any form of earned income, these rewards are subject to tax.

Your tax rate is written in the 'tax envelope' together with the tax burden (rounded to the lower 1,000 lire), that you should pay.

Before paying the tax you should answer the questions given to you with these instructions.

The operations that you must perform in payin your tax are the following (you cannot take more than three minutes to do everything):

1) enter the polling-booth;
2) put the money for the tax in the 'tax envelope' together with your answers to the questions;
3) put the remaining money in the 'personal reward envelope', and one of the two identification tickets in the 'ticket envelope';

4) seal all the envelopes;
5) join all the envelopes together with the clip;
6) keep the second ticket for yourself; do not show it to anyone, you will use it at the end to cash your money;
7) put the envelopes in the box for your group (i.e. 'more work' box or 'less work' box), then go back to your seat and wait until all the other participants have finished paying their tax.

You should bear in mind that if you pocket the whole reward without using the 'personal reward envelope' you will lose the right to anonymity and the right to receive your personal reward.

If you decide to evade tax you run the risk of being detected by the tax inspectors, in which case (only if your evasion is detected) you must pay your debt plus the following fines:

I) evasion of less than 30% of the amount due: a fine amounting to 50% of the tax evaded;
II) evasion of 31% to 60% of the amount due: a fine amounting to 80% of the tax evaded;
III) evasion of more than 61% of the amount due: a fine amounting to 140% of the tax evaded;

The procedure used to carry out the fiscal enquiry is identical to that followed by the revenue office. The procedure, which will ensure your anonymity, is as follows:

After the envelopes to be inspected (more precisely the sets of three envelopes held together with the clip) have been selected,

a) the 'personal reward envelopes' and the 'tax envelopes' will be opened;
b) if tax evasion is found, the fine will be applied, with the remaining money being put back into the 'personal reward envelope';

c) the 'ticket envelope' will not be opened (unless both the 'personal reward envelope' and the 'tax envelope' are empty). In this way, therefore, also the anonymity of tax evaders will be ensured anonymity.

Eventually will be opened all the remaining 'tax envelopes' with the aim to collect the information about the choices made by the subjects. No fine will be applied to these envelopes. We will keep the 'tax envelopes', while the 'personal reward envelopes' (closed) and the 'ticket envelopes' (obviously still closed and glued to the 'personal reward envelopes') will be put into a box, shuffled, and distributed to the participants using the reference ticket."

The instructions for the second group (group B, public audit, absence of any redistribution of tax yield) are identical to those just stated, the only difference being that no form of anonymity is guaranteed for the participants chosen for the fiscal audit.

The instructions for the third group (group C, total anonymity, partial redistribution of tax yield) are also largely identical with those of group A, with the addition of a further item of information:

"It is important that you should know that some of the total yield will be redistributed among all the participants. More precisely, 70% of the total yield will be distributed in identical individual portions. For example, if the total yield (i.e. the sum of the individual payments by all the members of both the 'less work' and 'more work' groups) is 200,000 lire, then each participant will receive 12,500 lire."

Obviously, members of the fourth group (group public audit, partial redistribution of tax yield) received the group C instructions without any guarantees of anonymity for those audited.

6.1.2 Instructions for the experimental subjects: ST2 experiment

The instructions given to the subjects in ST2 are the same as those given in ST1, except for the following two statements:

a1) "Your tax rate is written in the 'tax envelope' together with the amount of tax burden (rounded to the lower 1,000 lire) that you should pay."
b1) "The procedure used to carry out the tax inspection is identical to the one followed by the revenue office."

These were changed to:

a2) "The tax rate is 40% of your reward, and it is the same for all the participants. The amount of tax burden (rounded to the lower 1,000 lire) that you should pay is written in the 'tax envelope'."
b2) "Three people will be randomly chosen for a tax inspection."

6.2 Appendix A2

6.2.1 Questions contained in the tax envelope:ST1 exp.

These are the questions asked:

"a) According to you, what is your probability of being audited? Use the following scale to indicate your expected probability:

1------------------------------------7

min. probability max probability

b) How many of the other participants do you think will evade taxes? Write it as a percentage.

c) How much do you resent the fact that some of the other participants have decided to evade their taxes? Use the following scale:

1-----------------------------------7

low resentment high resentment

d) Do you know the Ministry of Finance's audit procedure?

e) In your opinion, how many Italians are audited each year by the Ministry of Finance? Write it as a percentage.

f) Describe the audit procedure that you believe is actually used by the Ministry of Finance."

6.2.2 Questions contained in the tax envelope:ST2 exp.

The questionnaire distributed to the participants to the ST2 experiment included questions b), c) and e) of the ST1 questionnaire plus the following new questions:

"g) How many Italians do you believe usually evade taxes? Write it as a percentage.

h) Do you believe that the tax rate used in the experiment is fair? Use the following scale:

1-----------------------------------7

unfair fair

i) In your opinion, what is the average income tax rate in Italy?

l) Suppose that the number of fiscal audits in Italy were doubled. In this case how much would tax evasion decrease?"

6.3 Appendix A3: OLS results for the ST1 experiment

The model:

$$\lambda^* = f(\Psi, K, S, Y)$$

where: λ^* = amount of money evaded (continuous variable);

K = moral constraint (binary variable);

S = anonymity (binary variable);

Y = income level (binary variable);

Ψ = disappointment at knowing that someone has evaded (continuous variable).

These are the results obtained:

$$\begin{aligned}\lambda^* = -\,1286.82 \underset{(-\,1.415)}{-\,3588.85\,\Psi} \underset{(-\,1.723)}{-\,2885.51\,K} \underset{(-\,1.570)}{-\,2490.52\,S} + \\ \underset{(4.521)}{+\,7241.68\,Y}\end{aligned}$$

Standard error = 6071.72

R^2 = 0.38

F = 7.68

S.E. = 6071.72

(the bracketed values are t statistics)

The significance of the t statistic is good only for Y, and immediately on the border of acceptability for K (0.09). All the other variables should be removed from the model. Nevertheless, in this case too, the signs of the explicative variables confirm our general assumptions. The coefficient of multiple correlation is quite low: only 38% of the variance of the dependent is explained by the model. The F statistic is significant and therefore allows us to reject the independence hypothesis.

6.4 Appendix A4: Instructions for the experimental subjects of the dynamic experiments

These are the instructions given to the participants of the experiments DY1, DY2, DY3, DY5:

"This game is about the behaviour of tax payers. The game is computer aided, the software that you will use is pre-built, and there will be no direct intervention by the researchers during the experiment. The results of your choices will be collected only when the experiment has finished, and they will remain anonymous.

The game simulates a real world environment. It comprises several rounds which represent different time periods (for example years). In each period you will receive a round income (which at the end will be your reward for the work you have done). In each period you will also be required to pay a tax, but you can decide to evade part of this tax, or even all of it. Regardless of your choice, you may be investigated at any moment during the game, and if you have evaded in one or more of the last five rounds you must pay the taxes evaded plus a fine. The inspection may never take place, and it is decided and performed only by the computer, without any direct or indirect intervention by the researchers.

All relevant information will be provided directly on the computer screen, and you must not communicate with anyone during the whole experiment.

This is the sequence that you must follow in each round of the game:

1) get the information about your round income and the tax to pay;
2) decide the amount of tax to pay (between zero and the total amount required);
5) press the enter key.

If you do not perform the entire routine, the computer will not allow you to pass to a new round, and you will have to repeat everything."

The experimental subjects of DY4 experiment received this modified instructions:

"This game is about gambling. The game is computer aided, the software that you will use is pre-built, and there will be no direct intervention by the researchers during the experiment. The results of your choices will be collected only when the experiment has finished, and they will remain anonymous.

The game simulates a pure game environment: there are several rounds representing different game shots. In each round you will receive an amount of money to play with (which at the end will be your reward). In each period you must decide either to bet some of this money or to save it. Regardless of your choice, you may be selected for a tax inspection at any moment of the game, and if you have decided to bet in one or more of the last five rounds you will lose the bet and have to pay a fine. The extraction may never take place, and it is decided and performed only by the computer, without any direct or indirect intervention by the researchers.

All relevant information will be provided directly on the computer screen, and you must not communicate with anyone during the whole experiment.

This is the sequence that you must follow in each round of the game:

1) get the information about your round money and the bet;
2) decide the amount of money to bet (between zero and the total amount of disposable money);
5) press the enter key.

If you do not perform the entire routine, the computer will not allow you to pass to a new round, and you will have to repeat everything."

6.5 Appendix A5: Computation of the dynamic experiments expected values with Mathematica.

p1=p
p2= (1 - p1) p
p3= (1 - p2) p

```
p4= (1 - p3) p
prob = p1 + p2 + p3 + p4
uno= prob /. p -> .06 (* Probability of being audited on 4 round with p=6%  *)
due= prob /. p -> .1  (* Probability of being audited on 4 round with p=10% *)
tre= prob /. p -> .15 (* Probability of being audited on 4 round with p=15% *)
(* The following plots show the expected values for the lotteries *)
(* Audit = 6% Income = 1000 tax = 200 *)
p1=Plot[(uno (1000-tax-5.5*(200-tax))+ (1-uno) (1000-tax)), {tax,0,200}]
(* Audit = 6% Income = 1000 tax = 300 *)
p2=Plot[(uno (1000-tax-5.5*(300-tax))+ (1-uno) (1000-tax)), {tax,0,300}]
(* Audit = 10% Income = 1000 tax = 300 *)
p3=Plot[(due (1000-tax-5.5*(300-tax))+ (1-due) (1000-tax)), {tax,0,300}]
(* Audit = 10% Income = 1000 tax = 400 *)
p4=Plot[(due (1000-tax-5.5*(400-tax))+ (1-due) (1000-tax)), {tax,0,400}]
(* Audit = 15% Income = 1000 tax = 400 *)
p5=Plot[(tre (1000-tax-5.5*(400-tax))+ (1-tre) (1000-tax)), {tax,0,400}]
(* Audit = 15% Income = 800 tax = 400 *)
p6=Plot[(tre (800-tax-5.5*(400-tax))+ (1-tre) (800-tax)), {tax,0,400}]
Show[p1,p2,p3,p4,p5,p6]
```

6.6 Appendix A6: The "TEMAG" software

The TEMAG (Tax Evasion Multiple Agents Game) software enables simulation of repeated tax-paying situation, with a variable number of persons who may (depending on the experimental design) interact with each other. In particular, the software enables easy adjustment of the experiment's strategic variables (the experimental subjects' incomes, the tax rate, frequency of tax audits, etc.).

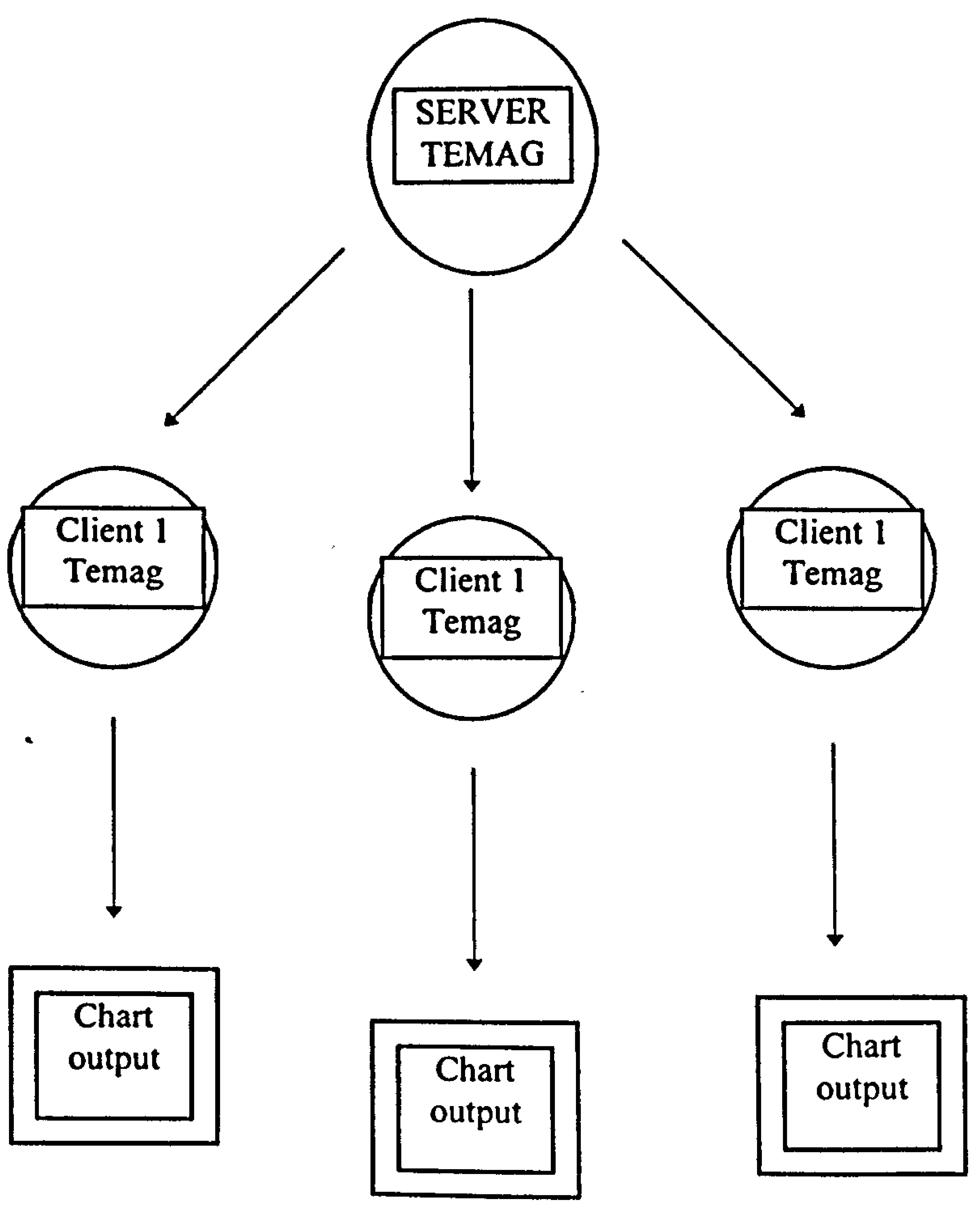
The following information is shown to the experimental subject on the computer screen:

1. income (on which tax must be paid);
2. amount of tax to be paid;
3. aggregate income;
4. probability of being audited;
5. progressive number of the decision (i.e. number of the round of the experiment);
6. income support (if envisaged by the experiment)
7. percentage of evaders previous round.

The information given to the subjects is extracted from an AQL (standard query language) database interrogated by the control program.

The software is divided into two modules: the 'server program' which supervises the experiment - recording the players, distributing information, and gathering decision data and the 'client' software, which is the interface between the player and the server.

The software architecture is shown in the figure:



The software module is the core of the program. It runs the experiment by linking the player program with the results recording program by means of an SQL database, and also records the decisions taken by the players. The programming language used to develop the software is 'objective C' language. This has characteristics which make it particularly suited to constructing programs which communicate via networks.

Once launched, the program server connects with the SQL database server in order to check that it is working properly. At this point the program is ready to accept the user's data relative to the experimental situation by means of special display. The experiment can be conducted simultaneously on several groups of subjects. This feature of the software means that the experiment can be conducted using computers located in different rooms, for example in two computer classrooms. At the beginning of the experiment, the database used by TEMAG to distribute information contains only some of the information communicated to the subjects round by round. The rest is gathered from the players' behaviour during the previous round, and is therefore constructed using real data.

Once the initial window has been compiled, the server shows the experiment monitoring window, which shows: the number of players, the current round, the income and tax yield of the last round. In the lower part of the window is a graph showing the average amount of tax paid in the various rounds. At this point the client programs start and communicate their presence and that they are working properly to the server. The latter updates its internal structure, which keeps track of the connections and, by incrementing the active clients counter, informs the experimenter of the event. When the number of active clients reaches the value previously introduced in the settings window, the server starts the experiment, distributing the information from the first round to all the clients that have notified that they are in operation, and informs the experimenter by means of a special dialog box.

The server then waits for communication by the clients of the amount of tax paid, once all the information has been collected and recorded in the database, and distributes the information on the second round. The two previous steps are then repeated until the number of rounds specified in the experimental conditions has been reached.

On start-up, after communicating information on its status to the server, the client waits for the start message. When it receives the signal, the client shows the user's code (necessary to ensure anonymity). If the subject has been checked by the tax authorities and identified as an evader, the client will display the fine that will be subtracted from the player's aggregate income. At the end of the game the subject is informed of this by a special message.

6.7 Appendix A7: Mann-Whitney test statistics

Tab A7.1 Mann–Whitney test Cat. 1TE1P

Standard exp. ---- Gamble exp.

Cluster 4 ← → Cluster 1 + 6

Test Statistics[b]

	AVGEVA	DEVSTEVA	MULTA	NUEVA	NUMULT	REDCUM	RSQ
Mann-Whitney U	34,000	56,000	90,000	96,500	85,000	93,500	57,000
Wilcoxon W	187,000	209,000	243,000	174,500	163,000	171,500	135,000
Z	-3,011	-2,037	-,532	-,244	-1,714	-,376	-1,994
Asymp. Sig. (2-tailed)	,003	,042	,595	,807	,087	,707	,046
Exact Sig. [2*(1-tailed Sig.)]	,002[a]	,043[a]	,616[a]	,811[a]	,471[a]	,711[a]	,048[a]

a. Not corrected for ties.

b. Grouping Variable: EXP

Tab A7.2 Mann - Whitney test Cat. MPSE

Standard exp. ---- Gamble exp.

Cluster 2 ← → Cluster 5 + 7

Test Statistics[b]

	AVGEVA	DEVSTEVA	MULTA	NUEVA	NUMULT	REDCUM	RSQ
Mann-Whitney U	,000	13,000	18,000	16,000	16,000	16,000	17,000
Wilcoxon W	21,000	34,000	39,000	37,000	37,000	37,000	38,000
Z	-2,887	-,802	,000	-,321	-,331	-,320	-,160
Asymp. Sig. (2-tailed)	,004	,423	1,000	,748	,741	,749	,873
Exact Sig. [2*(1-tailed Sig.)]	,002[a]	,485[a]	1,000[a]	,818[a]	,818[a]	,818[a]	,937[a]

a. Not corrected for ties.

b. Grouping Variable: EXP

Tab A7.3 Mann - Whitney test Cat. 1E1P

Standard exp. ---- Gamble exp.

Cluster 1 ← → Cluster 4

Test Statistics[b]

	AVGEVA	DEVSTEVA	MULTA	NUEVA	NUMULT	REDCUM	RSQ
Mann-Whitney U	,000	,000	5,000	3,500	6,000	4,000	,000
Wilcoxon W	6,000	6,000	11,000	18,500	12,000	19,000	15,000
Z	-2,236	-2,236	-,745	-1,200	-,512	-1,043	-2,236
Asymp. Sig. (2-tailed)	,025	,025	,456	,230	,608	,297	,025
Exact Sig. [2*(1-tailed Sig.)]	,036[a]	,036[a]	,571[a]	,250[a]	,786[a]	,393[a]	,036[a]

a. Not corrected for ties.

b. Grouping Variable: EXP

Tab A7.4 Mann - Whitney test Cat. MESP

Standard exp. ---- Gamble exp.

Cluster 6 + 3 + 5 + 7← → Cluster 2 + 3

Test Statistics[b]

	AVGEVA	DEVSTEVA	MULTA	NUEVA	NUMULT	REDCUM	RSQ
Mann-Whitney U	1,000	4,000	9,000	7,500	9,000	7,000	,000
Wilcoxon W	22,000	25,000	15,000	13,500	15,000	13,000	6,000
Z	-2,066	-1,291	,000	-,389	,000	-,516	-2,324
Asymp. Sig. (2-tailed)	,039	,197	1,000	,697	1,000	,606	,020
Exact Sig. [2*(1-tailed Sig.)]	,048[a]	,262[a]	1,000[a]	,714[a]	1,000[a]	,714[a]	,024[a]

a. Not corrected for ties.

b. Grouping Variable: EXP

Tab A7.5 Mann - Whitney test Cat. 1TE1P

Standard exp. ---- Redistribution exp.

Cluster 4← → Cluster 3

Test Statistics[b]

	NUEVA	AVGEVA	DEVSTEVA	REDCUM	MULTA	NUMULT	RSQ
Mann-Whitney U	21,500	,000	35,000	11,000	3,000	42,000	22,000
Wilcoxon W	49,500	28,000	63,000	89,000	31,000	70,000	100,000
Z	-1,737	-3,550	-,592	-2,620	-3,298	,000	-1,690
Asymp. Sig. (2-tailed)	,082	,000	,554	,009	,001	1,000	,091
Exact Sig. [2*(1-tailed Sig.)]	,083[a]	,000[a]	,592[a]	,007[a]	,000[a]	1,000[a]	,100[a]

a. Not corrected for ties.

b. Grouping Variable: EXP

Tab A7.6 Mann - Whitney test Cat. MPSE

Standard exp. ---- Redistribution exp.

Cluster 2← → Cluster 4

Test Statistics[b]

	NUEVA	AVGEVA	DEVSTEVA	REDCUM	MULTA	NUMULT	RSQ
Mann-Whitney U	5,500	,000	12,000	9,000	13,000	12,000	9,000
Wilcoxon W	26,500	15,000	27,000	30,000	34,000	33,000	24,000
Z	-1,755	-2,739	-,549	-1,095	-,366	-,582	-1,095
Asymp. Sig. (2-tailed)	,079	,006	,583	,273	,714	,561	,273
Exact Sig. [2*(1-tailed Sig.)]	,082[a]	,004[a]	,662[a]	,329[a]	,792[a]	,662[a]	,329[a]

a. Not corrected for ties.

b. Grouping Variable: EXP

Tab A7.6 Mann - Whitney test Cat. MPSE

Standard exp. ---- Redistribution exp.

Cluster 2← → Cluster 5

Test Statistics[b]

	NUEVA	AVGEVA	DEVSTEVA	REDCUM	MULTA	NUMULT	RSQ
Mann-Whitney U	9,500	,000	,000	3,000	2,000	10,500	,000
Wilcoxon W	19,500	10,000	10,000	24,000	12,000	20,500	21,000
Z	-,538	-2,558	-2,558	-1,919	-2,138	-,332	-2,558
Asymp. Sig. (2-tailed)	,591	,011	,011	,055	,032	,740	,011
Exact Sig. [2*(1-tailed Sig.)]	,610[a]	,010[a]	,010[a]	,067[a]	,038[a]	,762[a]	,010[a]

a. Not corrected for ties.

b. Grouping Variable: EXP

Tab A7.7 Mann - Whitney test Cat.

Standard exp. ---- Redistribution exp.

Cluster 1← → Cluster 2

Test Statistics[b]

	NUEVA	AVGEVA	DEVSTEVA	REDCUM	MULTA	NUMULT	RSQ
Mann-Whitney U	8.000	.000	8.000	5.000	5.000	5.500	7.500
Wilcoxon W	18.000	10.000	23.000	15.000	20.000	15.500	17.500
Z	-.490	-2.449	-.490	-1.225	-1.230	-1.173	-.615
Asymp. Sig. (2-tailed)	.624	.014	.624	.221	.219	.241	.539
Exact Sig. [2*(1-tailed Sig.)]	.730[a]	.016[a]	.730[a]	.286[a]	.286[a]	.286[a]	.556[a]

a. Not corrected for ties.

b. Grouping Variable: EXP

References

Ackerlof, G. A., 1980, "A theory of social custom of which unemployement not be one consequence", *Quaterly Journal of Economics*, 95, 749-795.

Adams J. S., 1965, "Inequity in social exchange", in: Berkowitz L. (ed.) *Advances in experimental social psychology*, Academic Press, New York, p. 167-299.

Alesina, A. and Marè, M., 1996, "Evasione e Debito" in: Monorchio, A. (ed.), *La finanza pubblica italiana dopo la svolta del 1992*, Il Mulino, Bologna.

Allingham, M. G. and Sandmo, A., 1972, "Income Tax Evasion: A Theoretical Analysis", in: *Journal of Public Economics*, 1, 323-338.

Alm, J. Mc.Clelland, G. H. and Schulze, W. D., 1992, "Why Do People Pay Taxes?", in: *Journal of Public Economics*, 48, 21-38.

Alm, J., Jackson, B. R. and Mckee, M., 1992, "Estimating the Determinants of Taxpayer Compliance with Experimental Data", in: *National Tax Journal*, 1, 107-114.

Amemiya, T., 1985, *Advanced econometrics*, TJ Press, Padstow.

Arrow, 1970, *Essays in the theory of risk bearing*, North Holland, Amsterdam.

Baldry, J. C., 1985, "Income Tax Evasion and the Tax Schedule: some Experimental Results", in: *Public Finance*, 42, 357-383.

Baldry, J.C., 1986, "Tax evasion is not a gamble: a report on two experiments", in: *Economic Letters*, 22, 333-335.

Becker, G., 1968, "Crime and Punishment: An Economic Approach", in: *Journal of Political Economy*, 76, 169-217.

Becker, W. H., Buchner, H. J. and Sleeking, S., 1987, "The impact of public transfer expenditures on tax evasion: an experimental approach", in: *Journal of Public Economics*, 34, 243-252.

Benjamini, Y. and Maital S., 1985, "Optimal tax evasion and otimal tax evasion policy: behavioural aspects", in: Gaertner W. and Wenig A. (eds.), *The economics of the shadow economy*, Spinger-Verlag, Berlin.

Bernardi, L., 1989, "Per un'introduzione ad dibattito sul sistema tributario italiano e alle proposte di riforma", in: Pedone, A. (ed.), *La questione tributaria*, Il Mulino, Bologna.

Bernardi, L., and Buratti, C., 1986, "Irpef e Iva: un'analisi modellistica", in: Gerelli (ed.), 241-274.

Bernasconi, M., 1995, "Evasione fiscale in Italia ed evoluzioni recenti degli strumenti di contrasto", in: *La Finanza Pubblica Italiana*, rapporto 1995.

Bosco, L. and Mittone, L. "Tax evasion and moral constraints: some experimental evidence", in: *Kyklos*, vol. 50, 3, 297-324.

Cassone, A. and Cogno, R., 1987, "Il comportamento dell'evasione fiscale: una rassegna critica della letteratura", in: *Rivista di diritto finanziario e scienza delle finanze*, 2, 241-273.

Cerea, G., 1992, "Una stima 'prudenziale' dell'evasione dell'IVA nel settore del commercio", in: *Rivista di diritto finanziario e scienza delle finanze*, 51, 157-184.

Cerea, G., 1995, *I confini dell'evasione*, Università di Trento (mimeo).

Chang, O. H., Nichols, D. R. and Schultz, J. J., 1987, "Taxpayer Attitudes Toward Tax Audit Risk", in: *Journal of Economic Psychology*, 8, 299-309.

Chung, P., 1976, "On Complaints about 'High' Taxes: An Analytical Note", in: *Public Finance*, 31, 36-47.

Cowell F.A., 1990, *Cheating the government*, MIT Press, Cambridge MA.

Feige, E. L., 1989 (ed.), *The underground economies: Tax evasion and information distortion*, Cambridge University Press, Cambridge.

Fishburn, G., 1979, "On How to Keep Tax Payers Honest", in: *Economic Record*, 55, 267-270.

Frey, B. S. and Weck, H., 1983, "What produces a hidden economy? An international cross-section analysis", in: *Southern Economic Journal*, 49, 822-832.

Friedland, N. 1982, "A Note on Tax Evasion as a Function of the Quality of Information about the Magnitude and Credibility of Threatened Fines: Some Preliminary Research", in: *Journal of Applied Social Psychology*, 12, 1, 54-59.

Friedland, N., Maital, S., and Rutenberg, A. 1978, "A Simulation Study of Income Tax Evasion", in: *Journal of Public Economics*, 10, 107-116.

Gaburri A. 1996, "Approccio sperimentale all'evasione fiscale: un'applicazione", University of Trento (B.A. Dissertation).

Gordon, J. P. F. 1989, "Individual morality and reputation costs as deterrents to tax evasion", *European Economic Review*, 33, 797-805.

Gutmann, P. M., 1985, "The subterranean Economy", in: *Studies in Contemporary Economics series*, vol. 15, 1985, pages 2-18.

Heider. F., 1958, *The psychology of interpersonal relations*, Wiley, New York.

Hewstone, M., 1991, *Attribuzione causale: dai processi cognitivi alle credenze collettive*,(It. Edition), Giuffrè Editore, Milano.

Hirshleifer, J. And Riley G., 1992, *The analytics of uncertainty and information*, Cambridge Univ. Press, Cambridge.

Hite, P. A., 1987, "An Application of Attribution Theory in Taxpayer Noncompliance Research", in: *Public Finance*, 1, 105-118.

Hite, P. A., 1990, "An experimental Investigation of the Effect of Tax Shelters on Taxpayer Noncompliance", in: *Public Finance*, 1, 90-108.

Jones, E. E. and Davis, K. E., 1965, "From acts to dispositions: the attribution process in person perception", in: Berkowitz, L. (ed.), *Advances in experimental social psychology*, Academic Press, New York.

Jones, E. E. and Nisbett, R. E., 1972, "the actor and the observer; divergent perceptions of the causes of behaviour", in: Jones, E. E., Kanouse, D. E., Kelley, H. H., Nisbett, R. E., Valins, S. and Weiner, B. (eds), *Attribution: perceiving the causes of behaviour*, General Learning Press, Morristown, N.J.

Kaplan, S. E. and Reckers, P. M. J., 1985, "A Study of Tax Evasion", in: *National Tax Journal*, 1, 97-102.

Kaplan, S. E., Reckers, P. M. J. and Reynolds, K. D., (1986), "An Application of Attribution and Equity Theory to Tax Evasion Behaviour", in: *Journal of Economic Psychology*, 7, 461-476.

Kaplan, S. E., Reckers, P. M. J. and Roark, S. J., 1988, "An Attribution Theory Analysis of Tax Evasion Related Judgments", in: *Accounting Organisations and Society*, 4, 371-379.

Kelley, H. H., 1967, "Attribution theory in social psychology", in: Levine D. (ed.), Nebraska symposium on motivation, vol. 15, University of Nebraska Press, Lincoln.

Knight, F. 1921, *Risk, uncertainty and profit*, Houghton Mifflin, New York.

Kreps, D. M., 1990, *A course in microeconomic theory*, Harvester Wheatsheaf, Hemel Hempstead.

Kreutzer, D., and Lee D. R., 1986, "On taxation and understated monopoly profits", in: *National Tax Journal*, 39, 2, 241-243.

Laffont. J. J., 1975, "Macroeconomic constraints, economic efficiency and ethics: an introduction to Kantian economics", in: *Economica*, 42, 430-437.

Lee K., 1997, "Tax evasion, monopoly, and nonneutral profit taxes", in: *National Tax Journal*, LI, 2.

Myles, G. D. and Naylor R. A., 1996, "A model of tax evasion with group conformity and social customs", in: *European Journal of Political Economy*, 12, 49-66.

Naylor, R. A., 1989, "Strikes, free riders and social customs", *Quaterly Journal of Economics*, 104, 771-805.

O'Higgins, M., (1980), "Measuring the hidden economy: a review of evidence and methodology", Outer Circle Policy Unit, London.

O'Higgins, M., (1981), Aggregate measures of tax-evasion. An assesment", in: *British Tax Review*, 286-302.

Robben, H. S. J., Webley, P. Weigel, R. H., Warneıyd, K. E., Kinsey, K. A., Hessing, D. J., Alvira Martin, F., Elffers, H., Wahlund, R., Van Langenhove, L., Long, S. B. and Scholz, J. T., 1990, "Decision Frame and Opportunity as Determinants of Tax Cheating: An International Experimental Study", in: *Journal of Economic Psychology*, 11, 341-364.

Shafir, E., and Tversky, A., 1990, "Decision Making", in: D. Osherson, E. Smith (eds.), *Invitation to Cognitive Science*, MIT Press, Cambridge, Massachusetts.

Simon H., 1967, *Administrative Behaviour*, 3rd ed., Macmillan, New York.

Spicer, M. W. and Hero, R. E., 1985 "Tax Evasion and Heuristics; A Research Note", in: *Journal of Public Economics*, 26, 263-267.

Spicer, M. W. and Lee Becker, L. A., 1980 "Fiscal inequity and tax evasion: an experimental approach", in: *National Tax Journal*, 2, 171-175.

Spicer, M. W. And Lunstetd, S. B., 1976, "Understanding tax evasion", *Public Finance*, 40, 441-486.

Spicer, M. W. and Thomas, J. E., 1982, "Audit probabilities and tax evasion decision: an experimental approach", in: *Journal of Economic Psychology*, 2, 241-245.

Srivansan, T. N., 1973, "Tax Evasion: A Model", in: *Journal of Public Economics*, 2, 339-346.

Strumpel, 1968, "Contribution of Survey Research", in: *Quantitative Methods in Public Finance*, 29-42.

Sudgen, R., 1984, "Reciprocity: the supply of public goods through voluntary contributions", in: *The Economic Journal*, 94, 772-787.

Tanzi, V., 1982, *The underground economy in the United Staes and abroad*, D. C. Heath, Lexington, Massachussets.

Thibaut, J., Friedland N., and Walker L., 1974, "Compliance with rules: some social determinants", in *Journal of Personality and Social Psychology*, Vol. 30, n. 6, 792-801.

Thurman, Q., 1988, "Taxpayer Noncompliance and Attribution Theory: An Experimental Vignette Approach", in: *Public Finance*, 1, 147-156.

Tutino, S., 1992, "L'evasione contributiva", in: *Studi ed informazioni*, 4,27-52.

Tversky, A., and Kahnman, D., 1979, "Prospect Theory: An Analysis of Decision Under Risk", in: *Econometrica*, 47, 263-291.

Tversky, A., and Kahnman, D., 1992, "Advances in Prospect Theory: Cumulative Representation of Uncertainty", in: *Journal of Risk and Uncertainty*, 5, 297-323.

Visco, V., 1983 "Erosione ed evasione dell'imposta sul reddito delle persone fisiche", in: *Rivista milanese di economia*, 7, 101-110.

Vitaletti, G., (1986)"La struttura e la dinamica dell'imposizione diretta", in: Gerelli (ed.), *Il sistema tributario oggi e domani*, Angeli, Milano.

Vogel, J., 1974, "Taxation and public opinion in Sweden: an interpretation of recent survey data", *National Tax Journal*, 27, 449-513.

Von Neumann J., and Morgenstern (1947), *Theory of games and economic behaviour*, Princeton Univ. Press, 2nd ed., Princeton.

Wald, A., 1943, "Tests of statistical hypotheses concerning several parameters when the number of observations is large", *Transaction of the American Mathematical Society*, 54, 426-482.

Wang L. F. S., 1990, "Tax evasion and monopoly output decisions with endogenous probability of detection", in: *Public Finance Quaterly*, 4, 480-487.

Wang L. F. S., and Conant J. L., 1988, "Corporate tax evasion and output decisions of the uncertain monopolist", in: *National Tax Journal*, 41, 579-582.

Webley, P. and Halstead, S., 1986 "Tax evasion on the micro: significant simulations or expedient experiments?", in: *Journal of Interdisciplinary Economics*, 1, 87-100.

Webley, P., Morris, I. and Amstutz F., 1985, "Tax evasion during a small business simulation", in: *Economic Psychology*, Proceedings of the tenthISREP Annual Colloquium, Linz.

Webley, P., Robben, H., Elffers, H., and Hessing, D., 1991, *Tax Evasion: An Experimental Approach*, Cambridge Univerity Press.

Yaniv, G., 1994, "Tax Evasion and the Income Tax Rate: A Theoretical Reexamination", in: *Public Finance*, 49, 107-112.

Yitzhaki, S., 1974, "A note on Income Tax evasion: A Theoretical Analysis", in: *Jornal of Public Economics*, 3, 201-202.